THE ENGINEER

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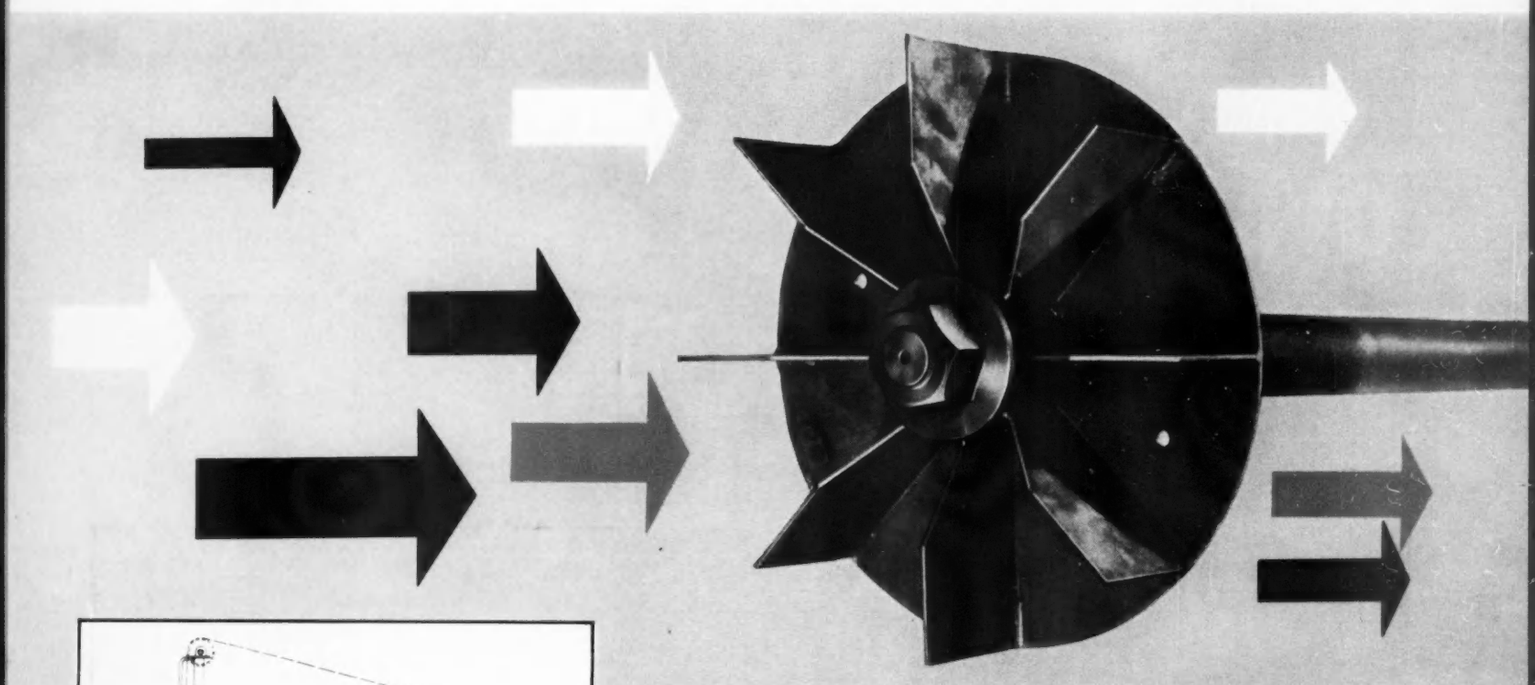

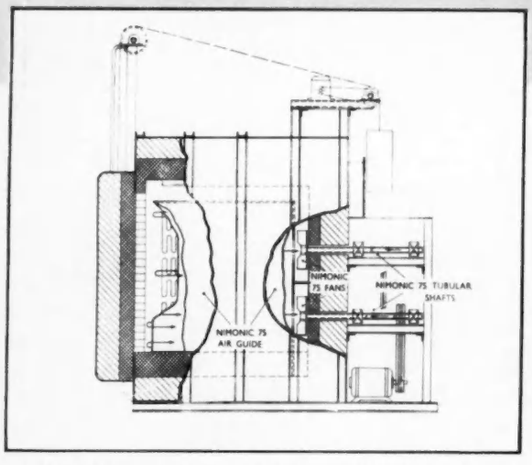

TOP *In addition to the forced-circulation fans and drive shafts, Nimonic* **75** *is used for the air-guide furnace liner which directs circulating air over the heating elements.*

INSET *Diagram shows forced-circulation system and the Nimonic 75 hollow fan-shafts cooled by compressed air.* *Trade Mark

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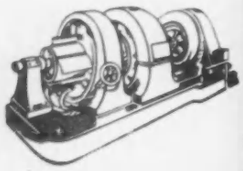

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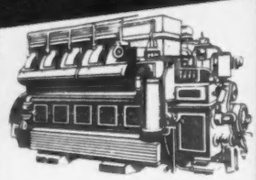

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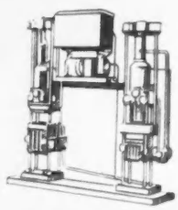

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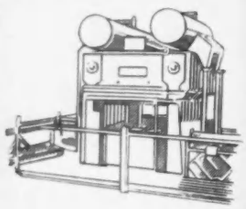

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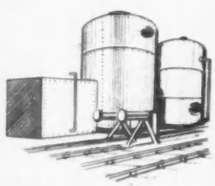

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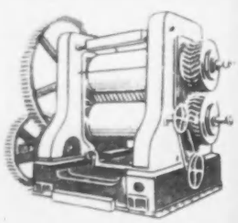

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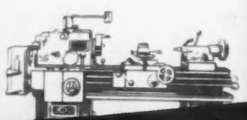

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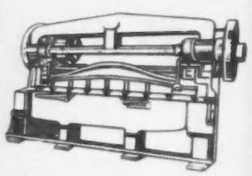

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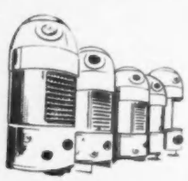

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Established 1856

No. 5433 **MARCH 11, 1960** VOL. 209

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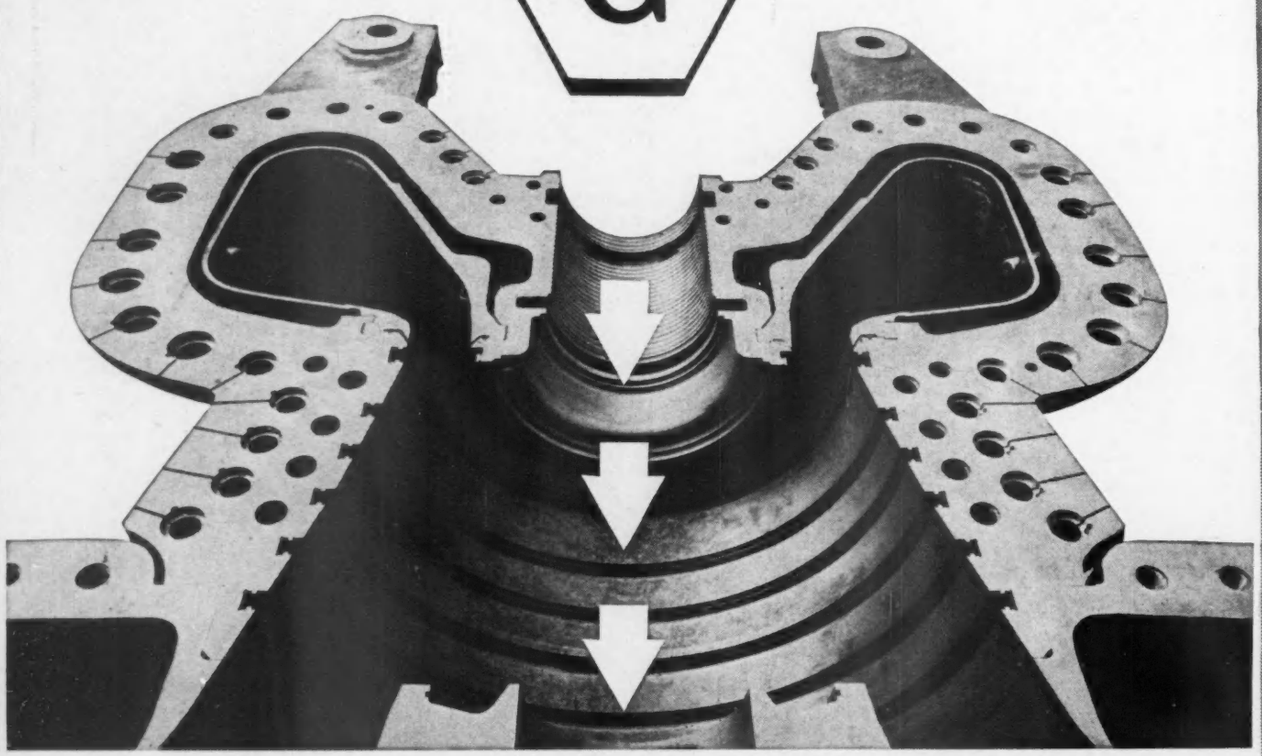

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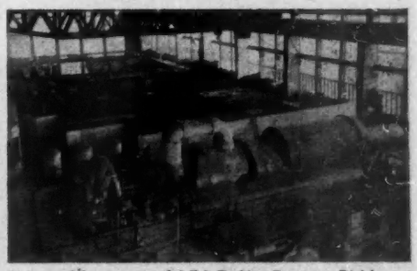

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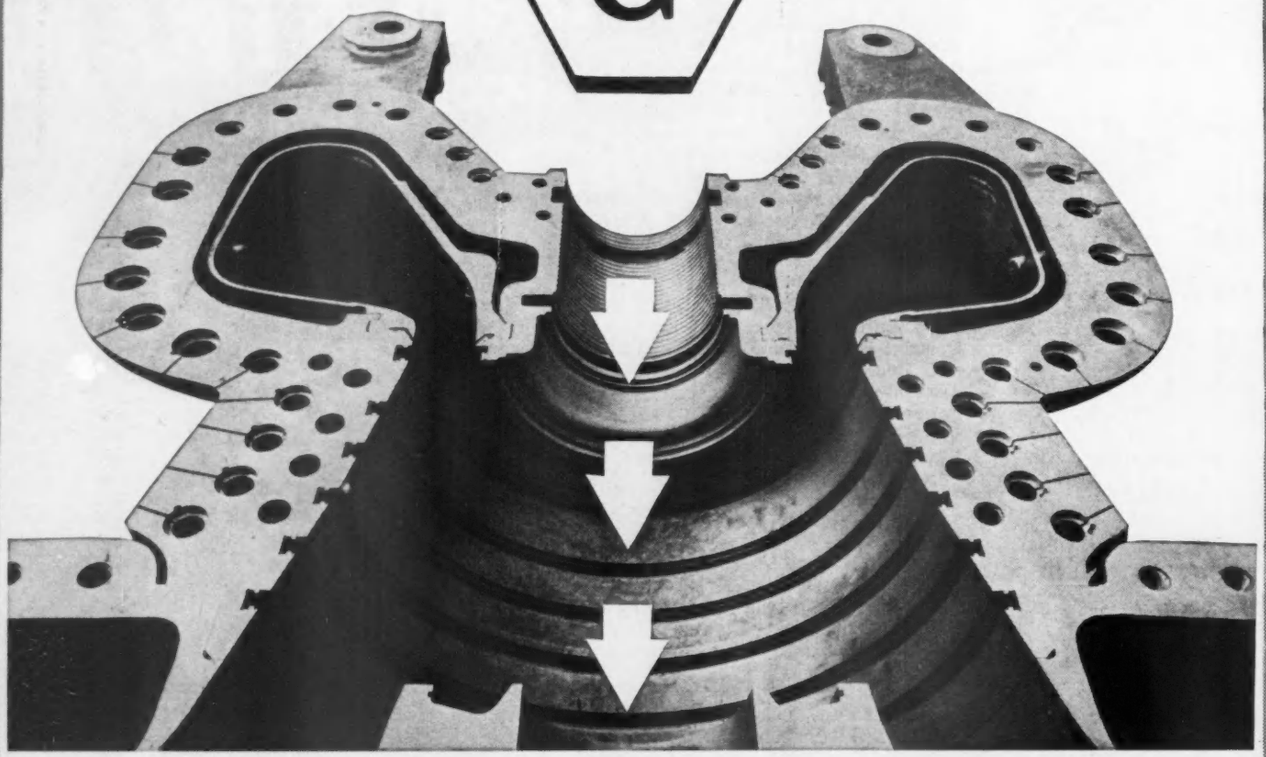

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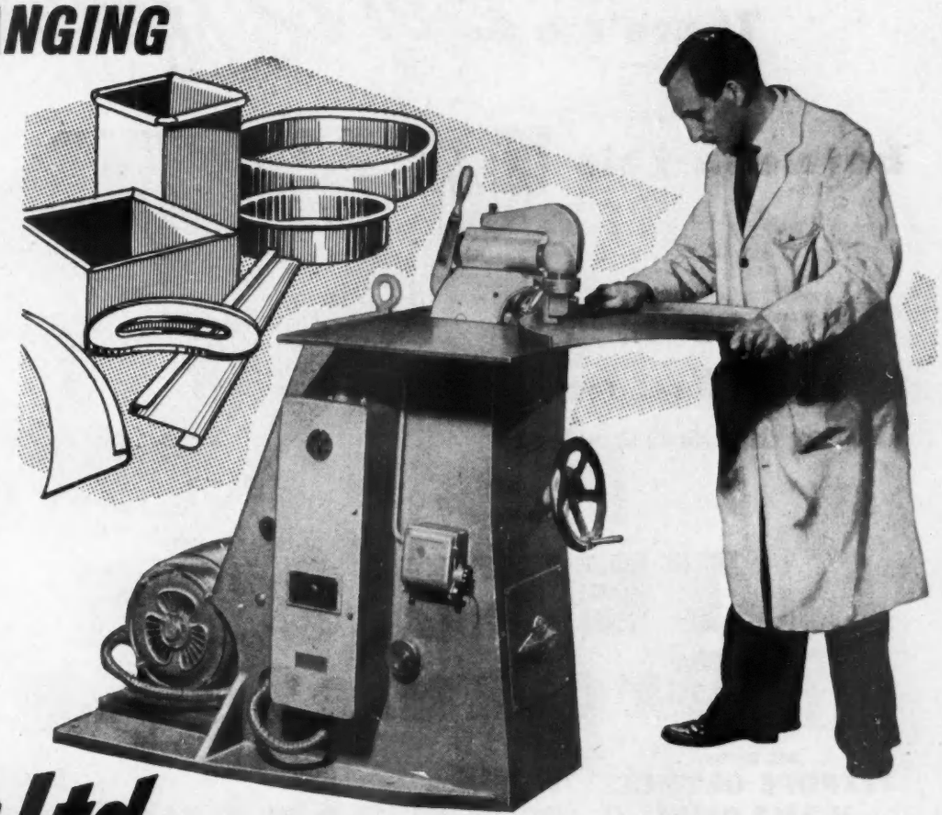

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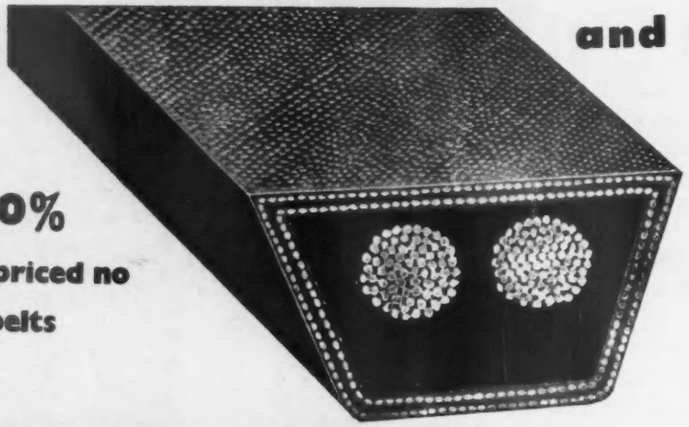

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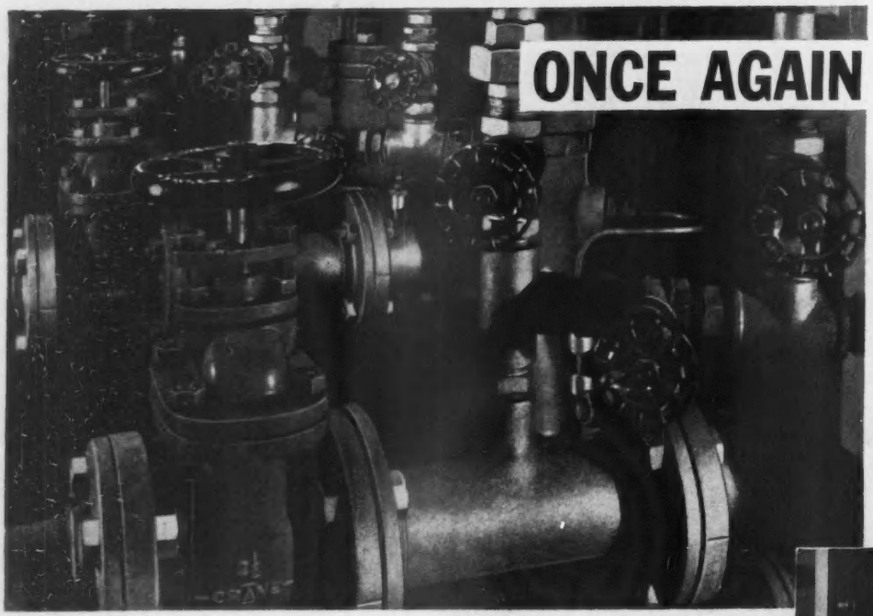

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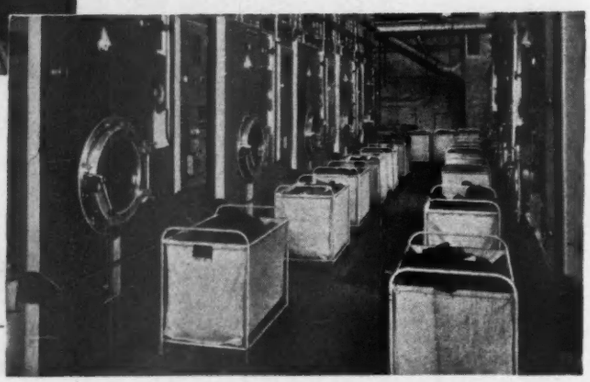

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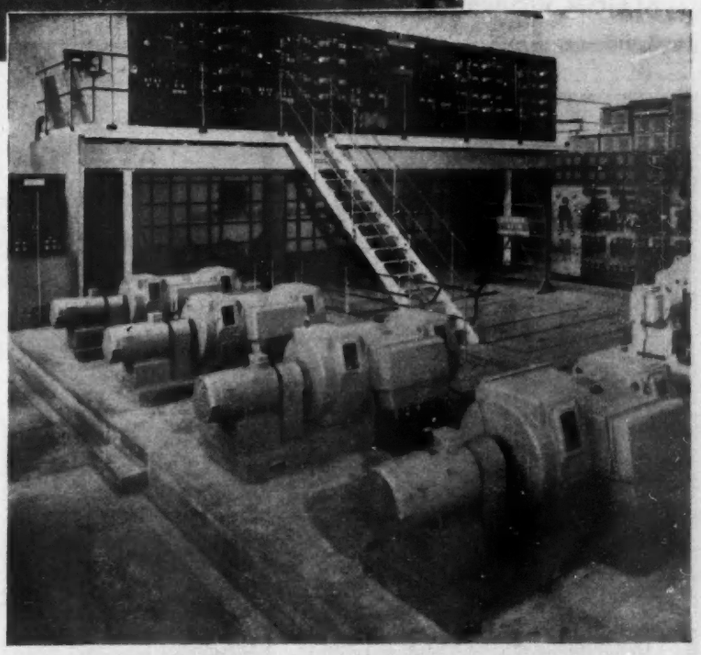

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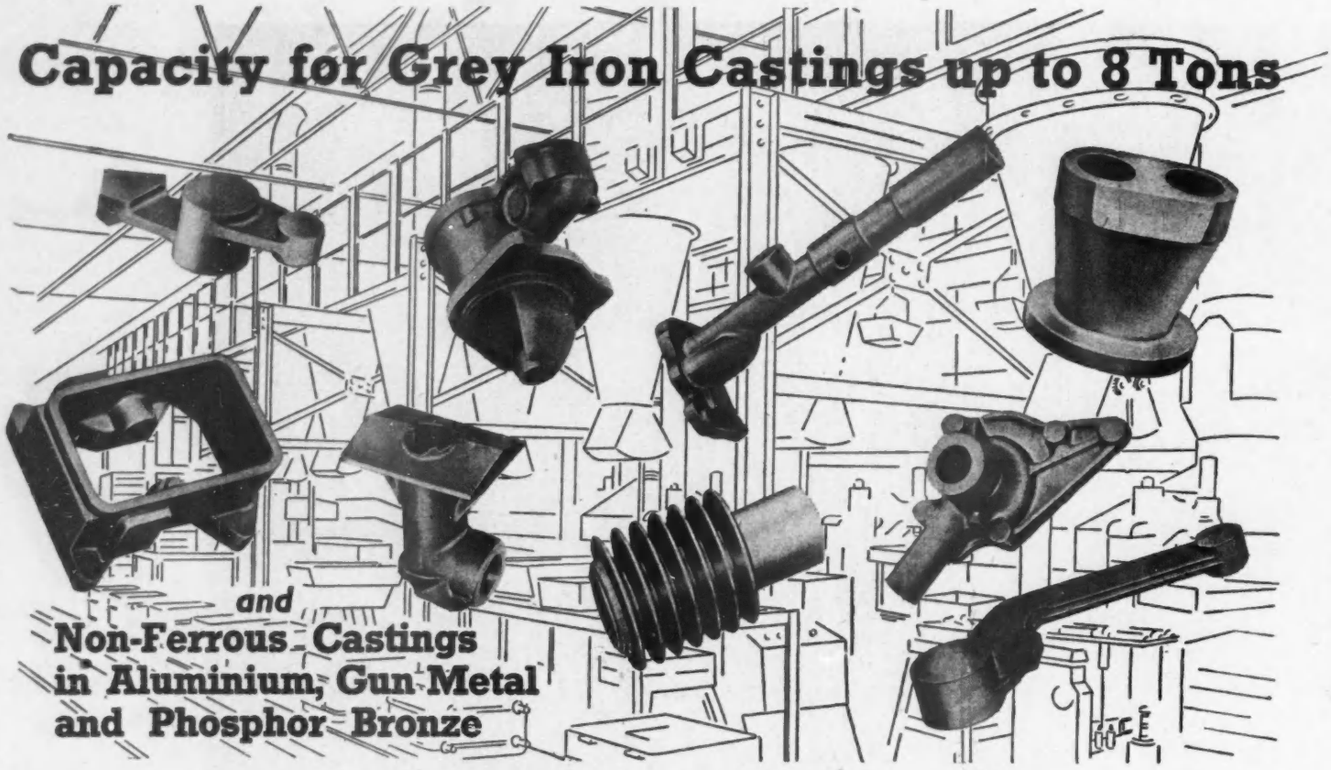

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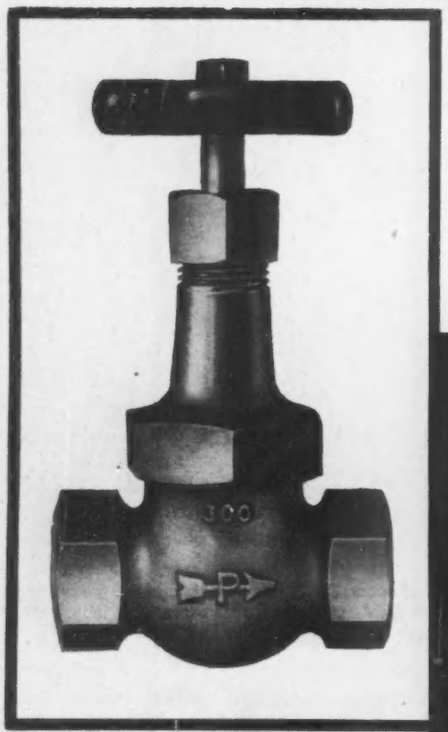

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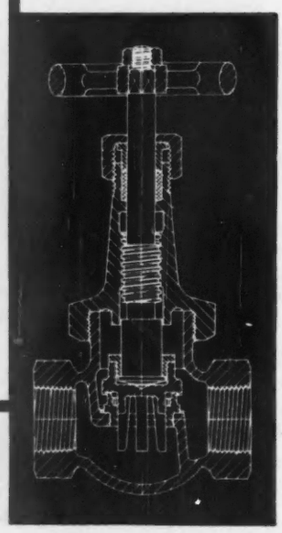

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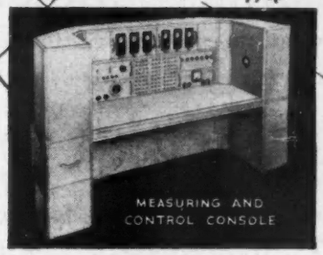

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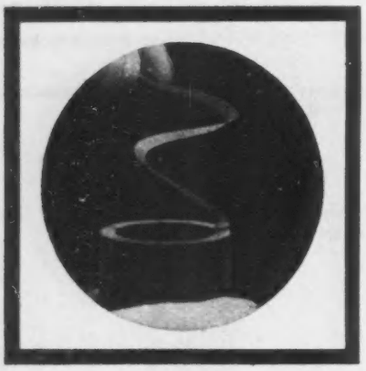
THE NEW TECALEMIT RIBBON FILTER ELEMENTS

set a fresh standard of high efficiency filtration for

AIR–WATER–PETROL, DIESEL AND FUEL OILS–LUBRICATING, HYDRAULIC AND OTHER FLUIDS



Tecalemit Ribbon Filter Elements

Simple construction—Low cost—High flow rate—Easy to clean

The elements are formed of resin impregnated cellulose ribbon, wound helically and electrically fused into an open-ended cylinder. Innumerable microscopic orifices between the ribbons allow a very high flow rate, while retaining impurities on the outside or inside surfaces, according to direction of flow.

The standard range of diameters (in any length) covers most applications, and no other filtration material can so readily be adapted to individual requirements for filters, strainers, breathers or separators. Never before has such fine filtration been possible at such low cost and with such flexibility in use.

Tecalemit Ribbon Elements filter to maximum purity

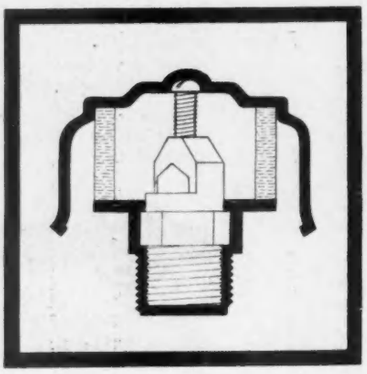
Tecalemit Air Breather Filters

(Incorporating Tecalemit Ribbon Filter Elements)

Cheapest—Most efficient—Cleanest to service.

Tecalemit Breathers act as ventilators to provide a free flow of clean air to hydraulic fluid, fuel and oil reservoirs. They give positive protection from airborne contamination to tanks, pumps, valves, cylinder and other engine components. Of the standard types, two are breathers with screwed bodies, and the third is a combined clip-on assembly of breather and filter cap. All are fitted with Tecalemit Ribbon Filter Elements.

Tecalemit Breathers provide pure air cheaply and efficiently



TECALEMIT

the authority on filtration

TECALEMIT LIMITED · (SALES EN) PLYMOUTH · DEVON

T698C

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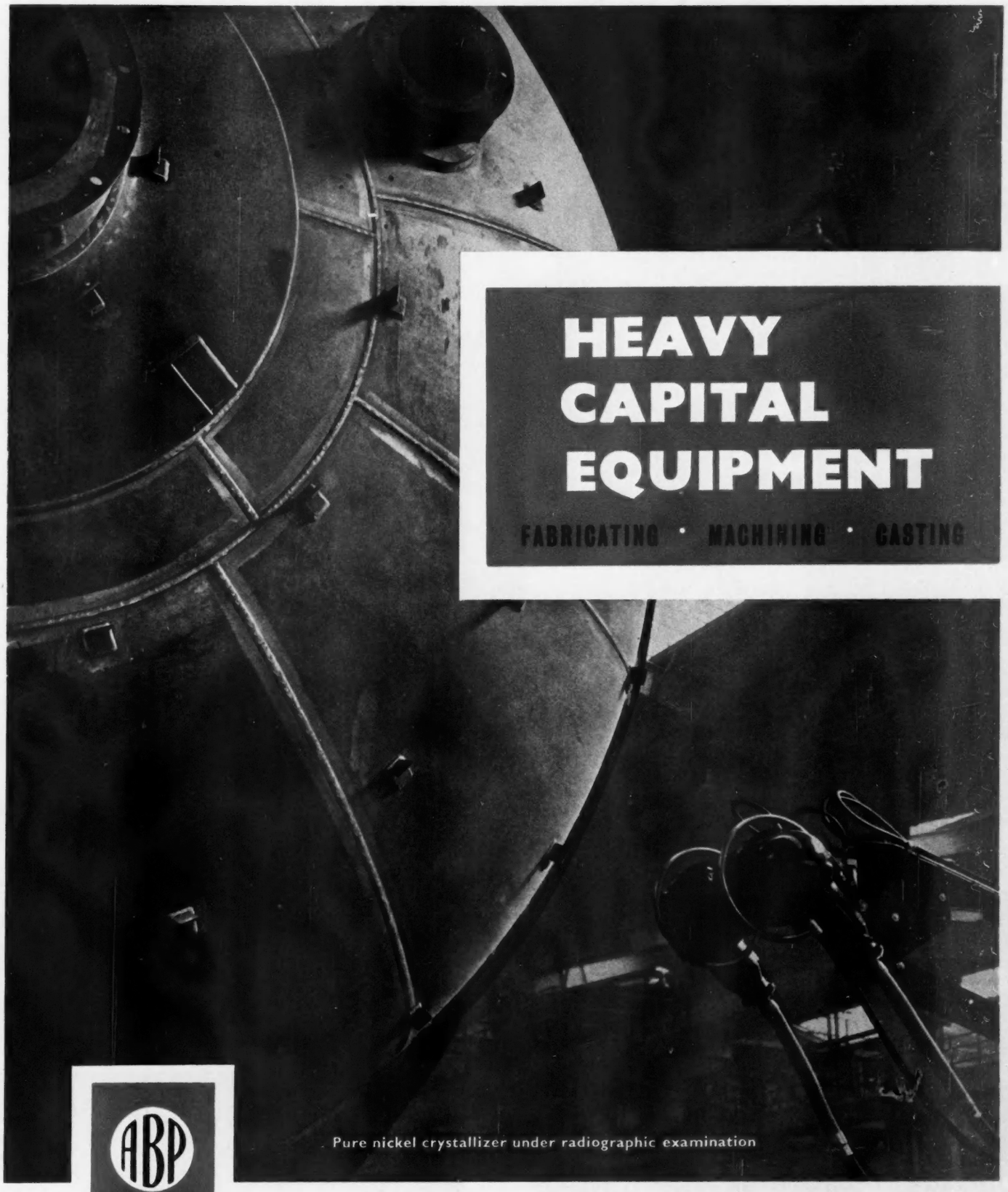

ASHMORE, BENSON, PEASE & COMPANY LIMITED

STOCKTON-ON-TEES AND LONDON

MEMBER OF THE

POWER-GAS GROUP

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COLES DIESEL-ELECTRIC

COLES CRANES

THE NAME THAT CARRIES WEIGHT IN YOUR INDUSTRY

The user value design features of COLES SELF-PROPELLED, TRUCK-MOUNTED and SHUNTING LOCO CRANES are appreciated by most of the biggest names and projects in the world. Here are some of them:

Snowy River Hydro-Electric Scheme; U.S.A. International Missile programme; every U.K. atomic project; Woomera Rocket Range; Boeing, Bristol Aircraft, De Havilland, Douglas Aircraft, Fairey Aviation, Handley Page, Hawker Siddeley, Saunders-Roe and Vickers-Armstrongs. Coles are in service with I.C.I.; Ports from London to Freemantle; Steelworks from Ravenscraig to Durgapur; B.P., Esso, Shell, Mobil; U.K., U.S.A. armed forces and most other forces throughout the world.

Coles handled Admiral Byrd's giant Sleighs, constructed for the Geophysical Year exploration; they unloaded Sir Vivian Fuchs' Sno-Cats, after the successful Trans-Antarctic exploration; a Coles Crane helped build 'Atomville' —the atomic village that serves the Monte Bellos Rocket Range in Australia.

For their outstanding combination of strength, mobility and accuracy with exceptional power flexibility, Coles have been chosen to carry out many important and precise operations, such as handling safely the largest piece of glass in the world and the costliest Rubens painting, 'Adoration of the Magi'. Coles Cranes were used in the loading and unloading of the statue of Christopher Columbus, shipped from Genoa to Columbus, Ohio.

* REGISTERED TRADE MARK

WIDE VISION CAB

Designed for maximum comfort plus efficiency, the operator is situated in a forward position on the full-circle-slewing superstructure—his eye is always on the hook, with large wide vision windows giving an unrestricted view of your working area.

ELECTRIC TRANSMISSION

Efficient and robust Electric Transmission provides a fully controlled smooth flow of power at the touch of a switch, with easy operation and simple maintenance without specialised knowledge. Hoist, slew, derrick and travel motions are independently powered and operated individually or in combination as required, with an infinite range of speeds from zero to maximum.

CRANES *are an investment in design*

ONLY COLES CAN CLAIM :—

(1) THE GREATEST ANNUAL PRODUCTION OF MOBILE CRANES.

(2) THE WIDEST RANGE OF LIFTING CAPACITIES.

(3) THE LARGEST MOBILE CRANE MANUFACTURING PLANT IN EUROPE.

(4) CRANE FACTORIES IN FULL PRODUCTION IN GREAT BRITAIN, U.S.A., AUSTRALIA AND WESTERN GERMANY.

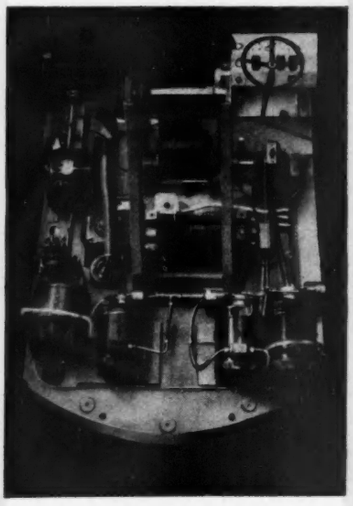
(5) MORE CRANES IN SERVICE THAN ANY OTHER MAKE OF MOBILE CRANES.

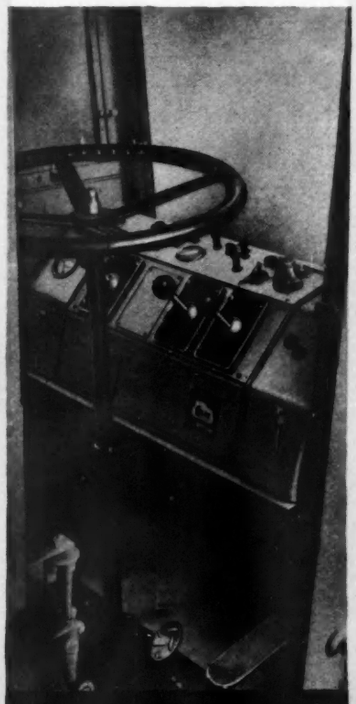
. . . and over 80 years' experience of the biggest, toughest and most complicated handling jobs is behind the design of Coles new range of Diesel-Electric Cranes; from Concrete to Air Engines, Coles flexibility counts.

When you use Coles you achieve speed and precision with safety.

UNIT CONSTRUCTION

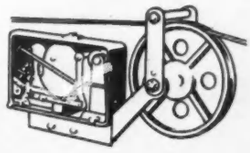
Coles Cranes are designed for maximum work with minimum maintenance; this clean, simple layout ensures easy maintenance with quickly removable, self-contained, totally-enclosed units. The superstructure base is accurately machined to receive the self-contained units of hoist, derrick and slew motions, power unit and generator. Easily removed panelling gives maximum weather protection and quick accessibility for ease of servicing.

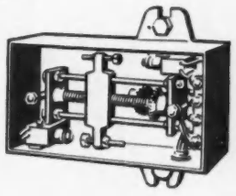


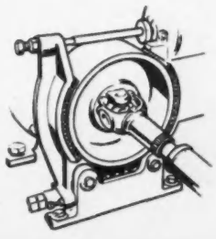


FINGER-TIP CONTROL

After only a few minutes instruction anyone can operate a Coles Crane. Pilot switches and accelerator are grouped together for easy, fatigue-free operation; every control movement is instinctive, leaving the operator free to concentrate upon signals and his load. Coles finger-tip electric control ensures a fresh, alert operator efficient to the end of the day—a vital safety factor.







SAFETY

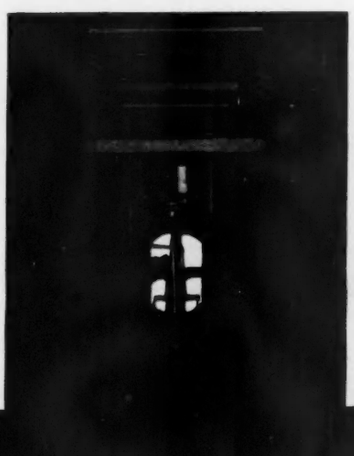
Coles many safety devices remove the human element risk and give the operator the security and confidence which enable him to work efficiently under all circumstances. In addition to the visual radius indicator which shows the safe working load, an automatic safe load indicator is fitted to weigh the load at a given radius, also giving the operator visual and audible warning of any tendency to overload—while preventing automatically the lifting of an unsafe load, irrespective of jib positions.

PRECISION WITH SPEED

Coles fast, finger-tip controlled motions provide an infinite range of speeds from zero to maximum. Faster, smoother, safer operation with maximum handling economy is obtained by simple operation of the accelerator pedal.

Designed, manufactured and marketed by:—

STEELS ENGINEERING PRODUCTS LIMITED,
Sunderland, England SALES AND SERVICE:
London, Birmingham, Manchester, Newcastle and Glasgow



EFFORTLESS TRAVEL

Coles Cranes move fast on the road and are designed for swift, easy movement from job to job, under all operating conditions; built specially to withstand the heavy stresses and shock loadings unavoidable on Crane duties. Our road travel experience is greater than any other European Manufacturer, let us pass this on to you.

FULL-CIRCLE SLEWING

The operator, situated on the front of the full-circle-slewing superstructure, can place the hook in any position within a circle, having a radius equally the length of the jib; he can reverse the motion and slew in the opposite direction without limit.

area occupied by crane 183·73 sq. ft.
98%
Area served by crane from standing position 5026·55 sq. ft.
A Coles full circle slewing crane operating with a 40' jib can efficiently serve an area of over 5,000 sq. ft.

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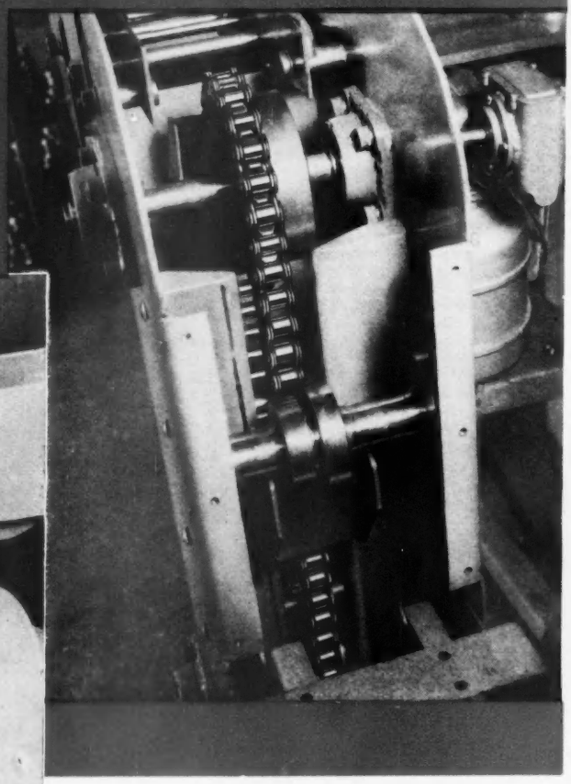
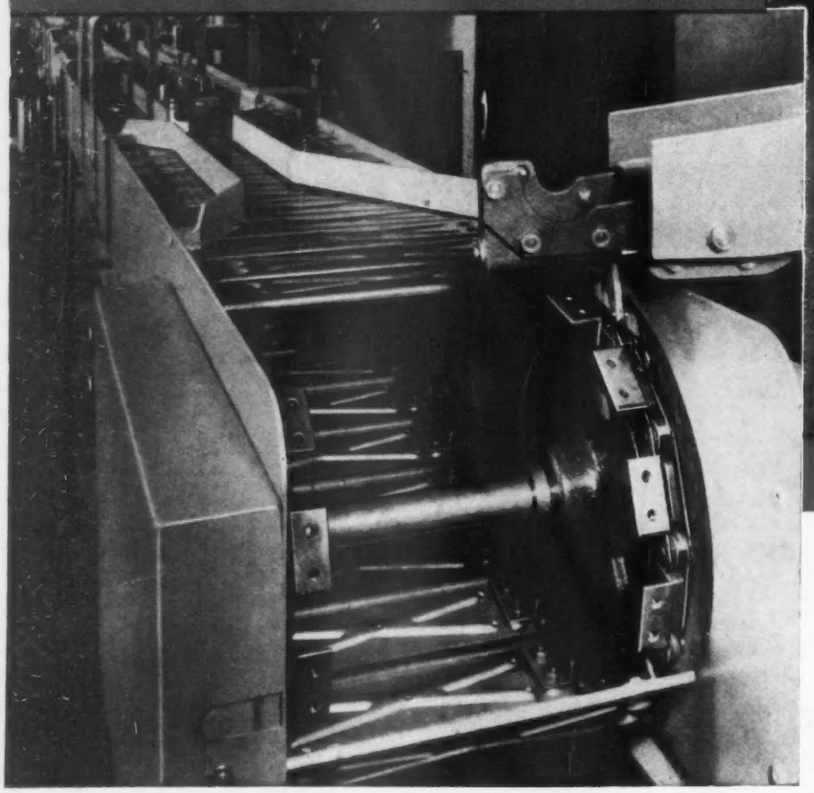
PERRY

are proud to have been associated with CHURCHILL GEAR MACHINES LIMITED of Blaydon-on-Tyne, Co. Durham, in the development of this Automatic Gear Production Unit . . .

Perry ½" pitch single roller chain drive and Perry Girder conveyor chain are fitted to the revolutionary Churchill Gear "Link-Line", which represents a major advance in the field of gear production and incorporates machine tools of latest design. The "Link-Line" is completely automatic in operation and processes gears through all stages of gear cutting.





Chosen by more and more manufacturers for continuous and dependable service under all conditions, PERRY Chains and Chain Drives are available from stock for virtually every industrial application. If you have a chain drive problem let PERRY solve it for you.

PERRY CHAINMAKERS TO INDUSTRY FOR OVER 70 YEARS

PERRY ENGINEERING LIMITED (Perry Chain Company Division)
Tyseley, Birmingham 27.

P1/42

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Problem: HEAT

Solution: COLT Ventilation

Place: LEYLAND MOTORS LIMITED
LEYLAND LANCASHIRE

The Architects, Messrs. Harry S. Fairhurst & Son F/A.R.I.B.A. who designed this factory for Leyland Motors Ltd. installed Colt Ventilators throughout for three reasons:

1. They had confidence in Colt Ventilation from past experience.
2. They liked the low silhouette which would not impair the appearance of the building.
3. The installation weighed 72 tons *less* than any other ventilation equipment available, thereby showing considerable saving in structural costs.

In providing a permanent solution to this ventilation problem Colt have added yet another chapter to their record of success—success which has brought repeat orders from many world-famous concerns. Send for a free Data Manual to Dept. S36/3A

COLT VENTILATION LIMITED SURBITON SURREY TELEPHONE: ELMBRIDGE 0161

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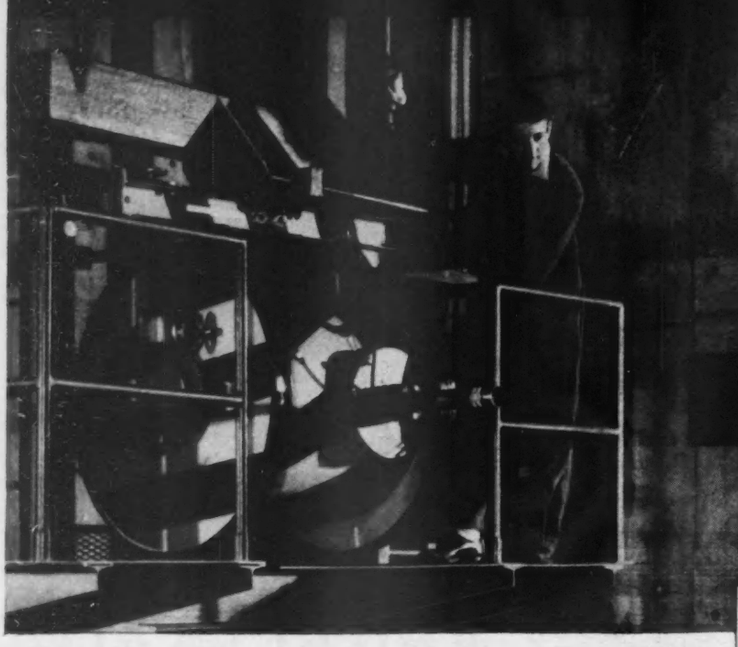
C

WORLD'S MOST POWERFUL COBALT 60 RADIOGRAPHIC UNIT



for non-destructive testing of steel plate 3 in. to 6 in. thick

NEWTON VICTOR COBALT 60 INDUSTRIAL EQUIPMENT

being set up for radiographic inspection of 4 in. welded plates which will later be shipped to Latina, Italy, for the new reactor vessel under construction by Whessoe Limited, Darlington, England.

This high intensity cobalt container for non-destructive testing is almost certainly the world's most powerful industrial radiographic unit. It embodies the results of years of experience in related medical equipment of Newton Victor manufacture.

Safe operation, ease of adjustment and robust construction are all provided by a unit which incorporates a source of 2,000 curies for the radiographic examination of welded seams in steel plate up to 6 in thick. Needing only small electric currents for control, and independent of water supplies it is suitable for work on open constructional sites in remote areas.

Check these important points:

POWERFUL The unit provides the equivalent of 3 million volt x-ray testing for 3 in to 6 in steel, with comparable sensitivity and economical exposure times.

SAFE Fully loaded provides ample protection—0.3 milli-roentgens per hour at 1 metre. Source housed in lead and tungsten alloy protective container is easily and safely moved from 'protected' to exposure position by use of the compact control unit.

ACCURATE Beam of radiation 6 in or 12 in wide by 5 ft long (15 or 30 cm by 150 cm) at a distance of 12 ft (360 cm) from source. Special light projector guide beam accurately 'pinpoints' centre of radioactive beam on specimen.

EASILY ADJUSTED Angulating mechanism permits rotation through 350° about both horizontal and vertical axes.

RELIABLE Stout construction and dust-tight, moisture-proof enclosure of container gives reliable operation under adverse conditions and extremes of climate.

For further particulars write to your local AEI office or direct to:

Associated Electrical Industries Limited

INSTRUMENTATION DIVISION-Scientific Apparatus & X-Ray Department

132-135, Long Acre, London, W.C.2

V/X902

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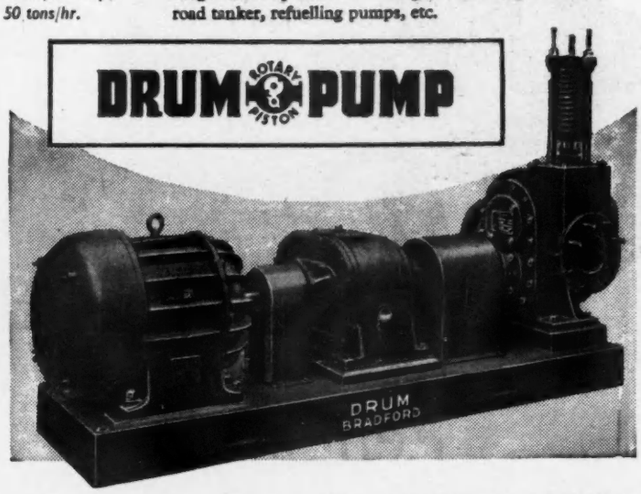
PUMPS
for the
PETROLEUM INDUSTRY

150 to 100,000 g.p.h.; temperatures up to 600° F.

DRUM Pumps meet the requirements of the petroleum industry in a unique way and are suitable for liquids from the most volatile to the most viscous, over a wide range of temperatures. Cargo, bunkering, transfer, road tanker, refuelling pumps, etc.

Below: Motor driven Oil Transfer Pump; 50 tons/hr.

DRUM ROTARY PISTON PUMP



THE DRUM ENGINEERING COMPANY LIMITED.
EDWARD STREET WORKS, DUDLEY HILL, BRADFORD, 4.
Dudley Hill 897/8
London Office:
38, Victoria Street, Westminster, S.W.1 Telephone: ABBey 3961
Branch Offices in Glasgow, Newcastle, Manchester and Birmingham
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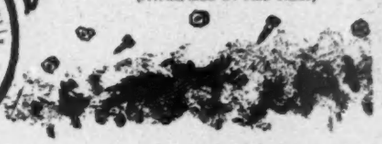
ANY NUTS OUT OF PLACE?

Bone shaking vibration can slacken the tightest nut. The way to smooth your worries is to fit KOLOK Positive Lock Washers. They come in every size.

KOLOK
POSITIVE LOCK WASHERS
(AVAILABLE IN ALL SIZES)



POSITIVE LOCK WASHER CO. LTD. 45 Renfrew Street, Glasgow, C.2. Telephone: DOUglas 9292
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How do you make up the losses in your boiler feed water system?
Untreated waters frequently contain scale-forming constituents and are unsuitable for direct use in Boiler Plant.
An Evaporator can provide pure Distilled Water at minimum cost.
May we help you with your Problem?

Caird & Rayner LTD
Specialists since 1889 in Evaporating and Condensing Plant, Feed Heaters and Filters, Oil Fuel Heaters and Exhaust Steam Oil Separators.
777 COMMERCIAL ROAD LONDON E14 Telephone: EASt 3216
Also Bushey Works By-pass Watford Herts.
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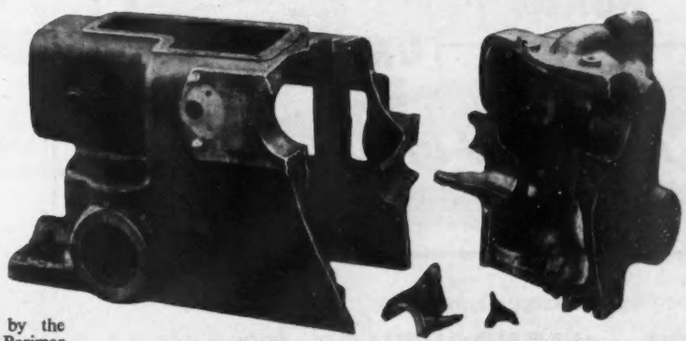
WHEN Hairbreadth Precision Counts

WHY Machine-tool Users insist on BARIMAR

Accurate welding and machining is a Barimar tradition—with over half a century of superb experience behind it ! In the case of repairs to broken machine tools, hairbreadth accuracy is a *sine qua non.*

Expensive precision parts, engaged on precision work, usually with contracts of the utmost urgency, call for prompt and highly experienced welding in the event of a mishap. This is the class of welding in which Barimar excels. The lathe saddle illustrated, broken in two through the surface feed housing, is typical of similar saddles, large and small, and of varied design which Barimar has repaired successfully. Some were damaged similarly to this saddle ; others have been broken through the traverse housings and elsewhere. No matter where the damage is, Barimar experts tackle the job with skill, accuracy and promptitude—*with special emphasis on ACCURACY.*

Barimar therefore illustrate this typical repair—perfectly welded, impeccably machined and covered as usual by the Barimar Money-Back Guarantee. This Barimar job saved time, expense, and a big material loss to the owners whose satisfaction earned Barimar yet another bouquet.



Many lathe saddles have been repaired by Barimar. This one was broken right through the surface feed housing.

PERFECT PRECISION was Barimar's standard when they repaired the lathe saddle under their Money-Back Guarantee, within a few days.

WHEN IT IS URGENT, 'PHONE BARIMAR AT ANY TIME OF THE DAY OR NIGHT

There is always someone to advise you—someone ready to help.

ALL BROKEN PARTS which are transportable must be sent CARRIAGE PAID or delivered to the nearest Barimar Branch. Please remove all fittings and post letter advising dispatch. When it is impossible to transport damaged machinery, Barimar experts operate ON THE SPOT.

BARIMAR LTD. **Barimar House, 22-24, Peterborough Road, FULHAM, LONDON, S.W.6**
Telephones: RENown 2147-2148. Night 2148. Telegrams: "Bariquamar, Walgreen, London."

BARIMAR Branch Addresses :
BIRMINGHAM, 12: 116-117, Charles Henry St. *Telephone: Midland 2696*
NEWCASTLE-UPON-TYNE, 1: 64-66, The Close. *Telephone:* 21055
GLASGOW, C.2: 134, West George Lane. *Telephone: Central 4709*

BARIMAR—THE WORLD'S SCIENTIFIC WELDING ENGINEERS

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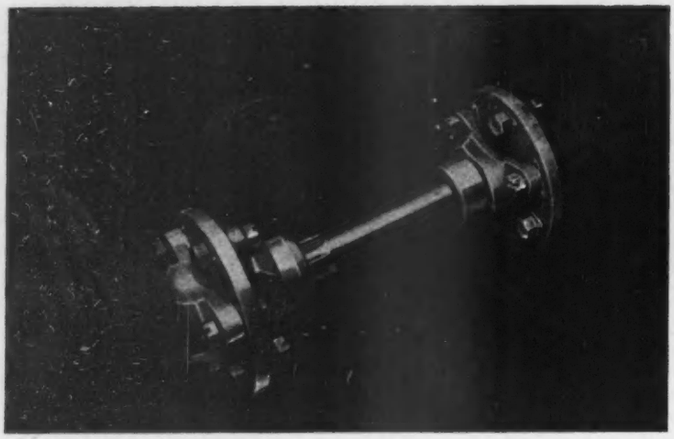
POWER TRANSMISSION—
through the medium of
FLEXIBLE FABRIC COUPLING DISCS



★ Are easily assembled.
★ Give extreme torsional flexibility.
★ Absorb irregularities in load variations.
★ Axial and parallel misalignments are corrected.

ESTABLISHED 1895
HERMETIC RUBBER Co LTD
Hermetic Works, Ryland Street, BIRMINGHAM, 16
'Phone : EDGbaston 0983/4 Telegrams : "Hermetic Birmingham."

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Are you interested in saving at least 25% of the cost?

Send for important information on

The METTEXTURE PROCESS

—the patented mechanical method of hacking old and damaged concrete to a precise depth, and providing an evenly keyed sub-surface to receive new topping.

The Mettexture Service provides equipment and trained operators in any locality.
ESTIMATES FREE

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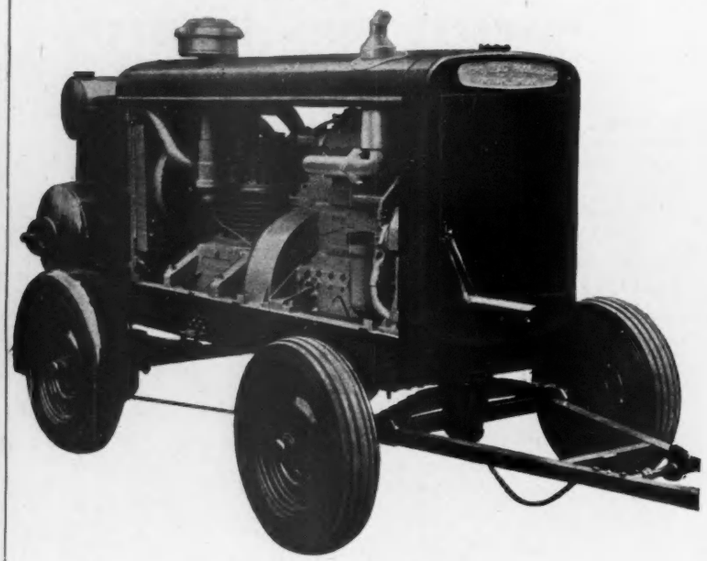
ROBUST...



Reliable

We design and build air compressors up to 210 c.f.m. F.A.D., trailer, stationary and semi-mobile. Compressors on special-purpose mountings can be produced quickly and at competitive prices. If you use compressors for any purpose it is worth while writing for particulars of our machines.

Makers of pure 'LEAD WOOL' for pipe jointing; caulking tools and pipeline testing equipment. Suppliers of high quality base metal—powders, solders, etc.

THE LEAD WOOL CO LTD
SNODLAND KENT

Phone : Snodland 516-7. Telegrams : **Strength** Phone Snodland

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Pusher Tug 'GONGOLA'

This Pusher Tug and a Train of eight close coupled barges was constructed by Yarrow to the order of the United Africa Company, for service on the Niger and Benue Rivers, West Africa. Overall length of the complete unit 630 feet, beam 66 feet, loaded displacement 4,650 tons.

YARROW

YARROW & CO. LTD
SCOTSTOUN · GLASGOW W4

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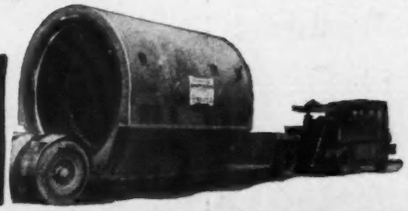
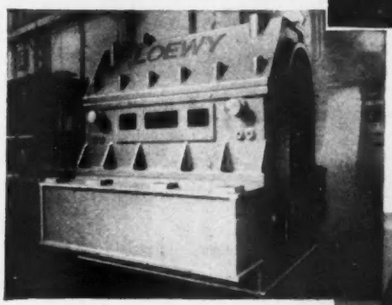
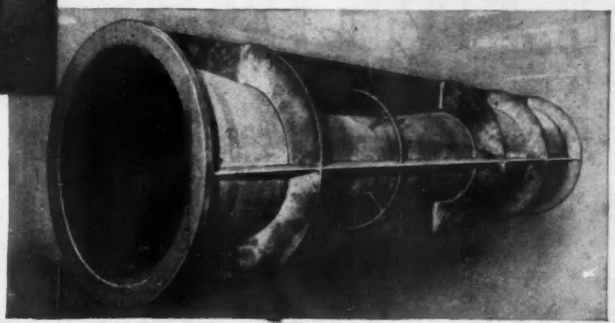
Heavy Welded Fabrications





For the ultimate in Welded Fabrications consult Empyrium, pioneers in this field.



Transformer and Switchgear Tanks; Storage Tanks for Petrol, Oil and Water; Autoclaves; Chemical Plant of all descriptions; Bedplates; Machine Tool and Press Frames; Gas Works Plant; Hoppers, Condensers, Gear Guards, Blast Mains, Air Receivers and Pressure Vessels of all types.
Empyrium fabricate for all industries to ASME and Lloyd's specification. Also to the exacting requirements of the Petroleum and Oil Companies. Full testing facilities, including X-Ray.

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WELDING & MANUFACTURING COMPANY LIMITED

Head Office and Main Works:
Pritchett Street, Birmingham 6.
Telephone: ASTon Cross 3203-4-5.
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PIONEERS IN WELDING PRACTICE SINCE 1917

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Consult

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for ROTARY UNIONS
(Patented)

USED ON AIR, STEAM, WATER, OIL &c.
FOR LEAKPROOF FLUID TRANSFER TO ROTATING MACHINERY
SIZES ¼"—3" BSP
SPECIALS UP TO 6" BORE

Unions fitted with carbon bearings are available for temperatures over 400° F

FILTON LIMITED
Clapham Street, Leamington Spa,
WARWICKSHIRE
Telephone Spa 8111/2

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COMPLETE PLANT for Waste Recovery and Effluent Treatment

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DESIGNERS AND SUPPLIERS OF ALL PROCESS PLANT

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INDUSTRIAL COUNTING INSTRUMENTS and MEASURING MACHINES

Let us solve your counting and measuring problems

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Use Off-Peak Tariffs and cut the cost of Heating with

Nightstor Heaters

CUT FUEL COSTS. Nightstor Heaters store heat by night—taking advantage of the cheaper off-peak tariffs available from all Electricity Boards—and dissipate heat by day. Separate thermostatic control ensures that the heaters use only the minimum current necessary to provide a comfortable temperature throughout the following day from first thing in the morning. Thus Nightstor Heaters are not only efficient and clean, they represent maximum economy.

CUT CAPITAL COSTS. Simple and inexpensive to install, without alteration to structures or fittings. Nightstor Heaters are compact units which can be safely placed right up against the wall. Thus using the minimum of floor space.

CUT MAINTENANCE COSTS. Controlled automatically, Nightstor Heaters once installed need no maintenance or attention.

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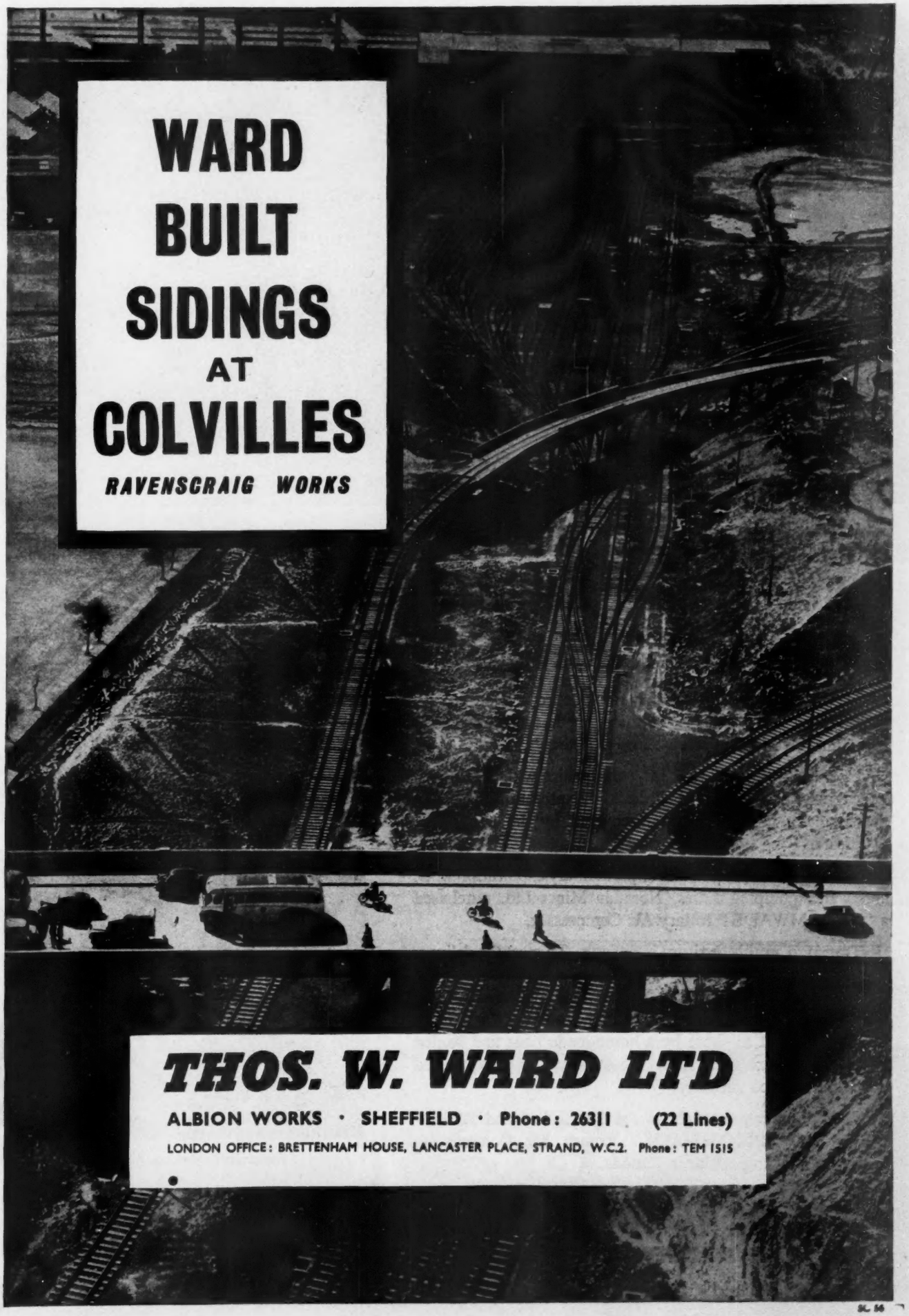

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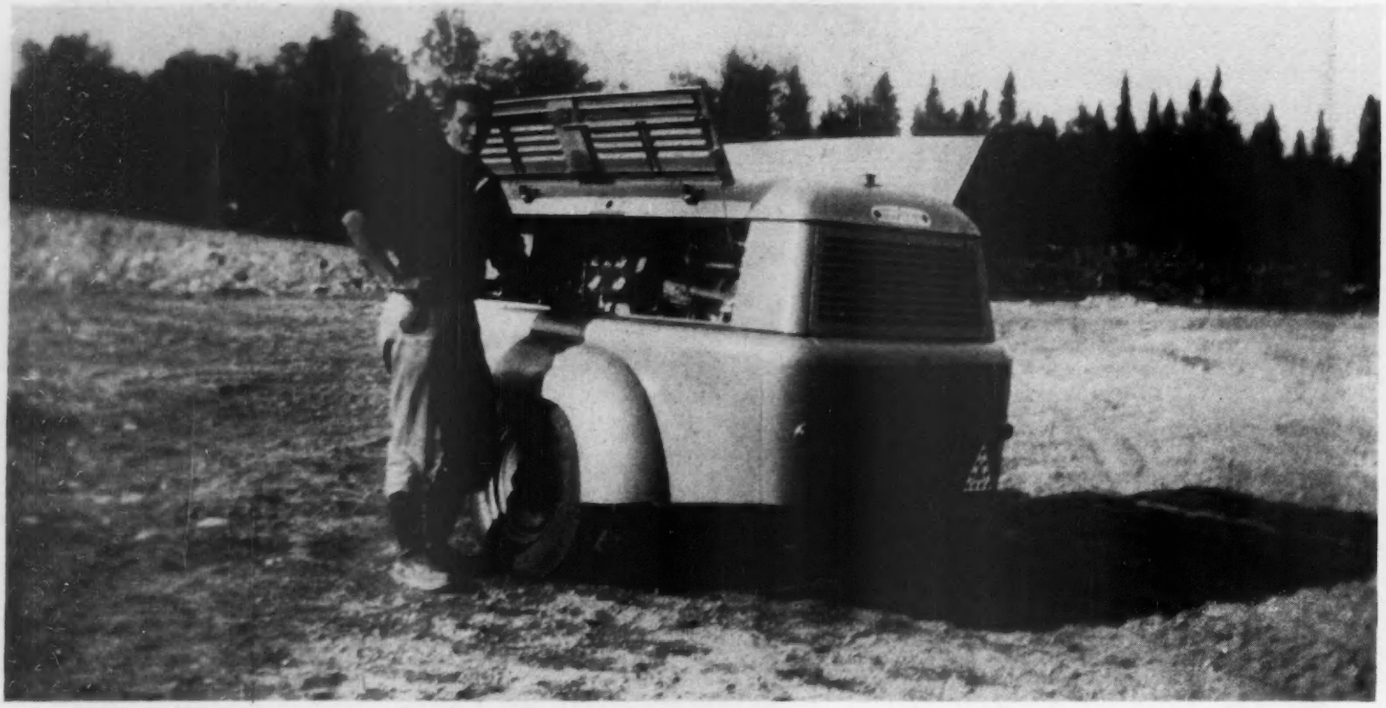

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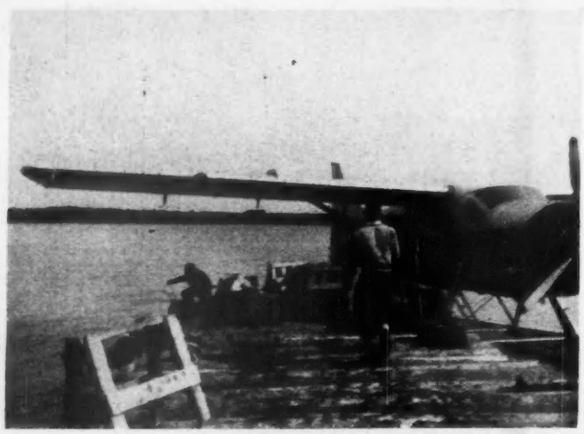
In the North-West Territory of Quebec conditions are tough. Men and machines work in temperatures from 85°F in summer to –40°/45° below zero in winter.

Noranda Mines Ltd., in partnership with McIntyre-Porcupine Mines Ltd. and Canadian Exploration Ltd., are developing a mining project discovered by the Mattagami Syndicate.

To supply compressed air for preliminary exploration work and water pumping duties, Noranda Mines Ltd. purchased a "BROOMWADE" Rotary Air Compressor.

Transport in this territory is difficult. To meet the delivery schedule, the Compressor plant was dismantled in the "BROOMWADE" Toronto Depot, the units packed and flown by a de Havilland "Beaver" 'plane to Lake Washwanipi then transported to shore by a home-made boat and hauled to the Mattagami site. After re-assembly, the plant started easily and worked perfectly.

This is but one example of the QUALITY and RELIABILITY of "BROOMWADE" Rotary Air Compressors which are now so popular in Canada.



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AIR COMPRESSORS & PNEUMATIC TOOLS—YOUR BEST INVESTMENT

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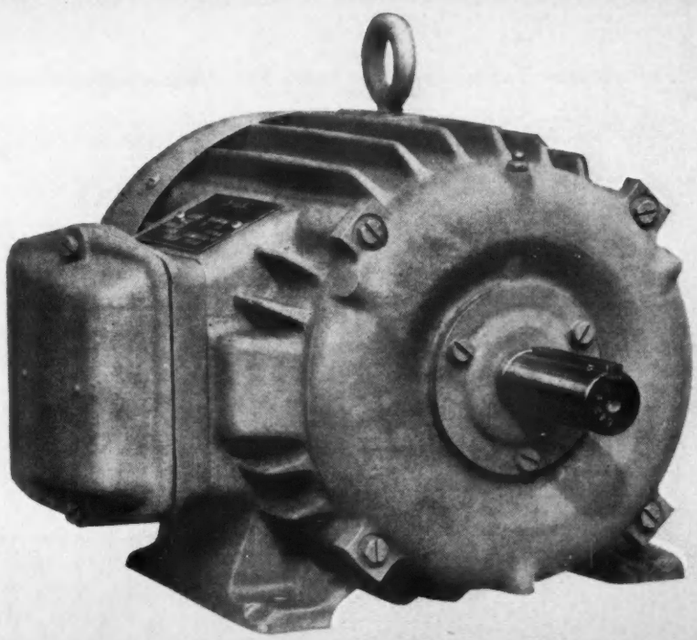
- Totally-enclosed, fan-cooled 'D' frames.
- Interchangeable with ventilated machines, ('C' frames) of the same ratings (B.S. 2960).
- Available from stock in outputs up to 7½ h.p., 1500 r.p.m., and 5 h.p., 1000 r.p.m., at 400/440 volts. Higher ratings up to 40 h.p. will be available shortly.



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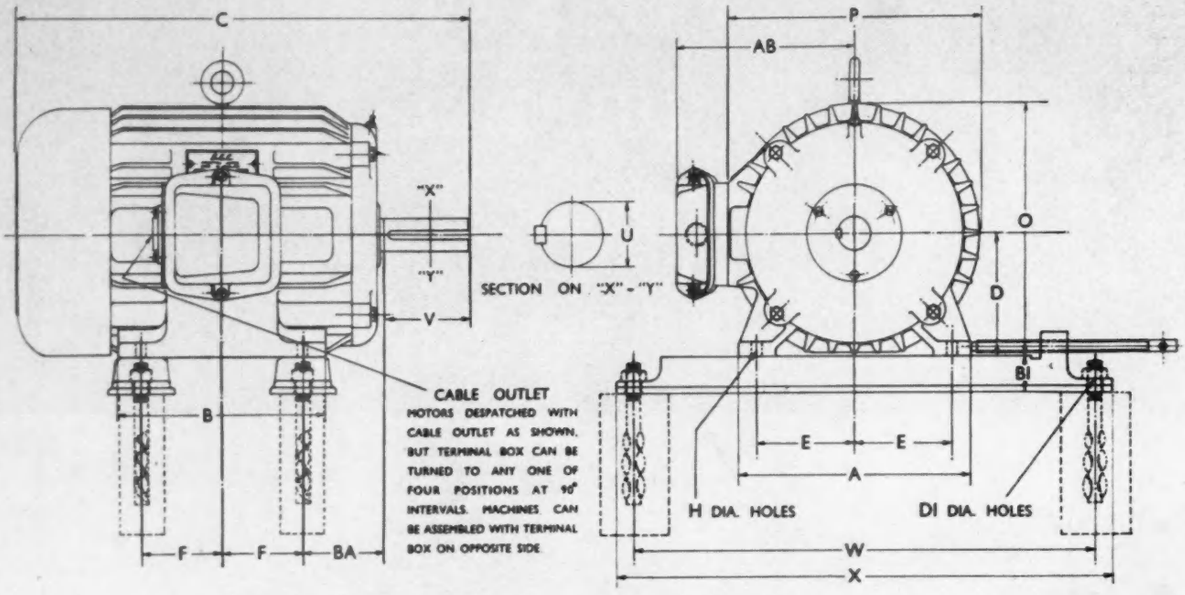
FOR RATINGS AND DIMENSIONS SEE OVERLEAF

D

The new squirrel cage motors

(with class 'E' insulation)

RATINGS AND DIMENSIONS



H.P.		Frame Size	Frame											Shaft Extension		Slide Rails			
1,500 r.p.m.	1,000 r.p.m.		A	AB	B	BA	C	D	E	F	H	O	P	U	V	W	X	BI	DI
1	½	D162	8	6½	5¼	2¾	13 5/16	4	3⅜	2	⅜	8 1/16	8⅛	·7500	2¼	20 3/32	21 21/32	1 9/16	¾
1½	¾	D164	8	6½	6¼	2¾	14¼	4	3⅜	2½	⅜	8 1/16	8⅛	·7500	2¼	20 3/32	21 21/32	1 9/16	¾
2	1	D182	9	7 1/16	6	2¾	14¾	4½	3¾	2¼	7/16	9 1/16	9⅛	1·1250	3	20 3/32	21 21/32	1 9/16	¾
3	2	D184	9	7 1/16	7	2¾	15¾	4½	3¾	2¾	7/16	9 1/16	9⅛	1·1250	3	20 3/32	21 21/32	1 9/16	¾
5	3	D213	10⅛	7⅝	7½	3½	18 9/32	5¼	4¼	2¾	7/16	10¾	11 1/32	1·3750	3¾	20 3/32	21 21/32	1 9/16	¾
7½	5	D215	10⅛	7⅝	9	3½	19¾	5¼	4¼	3½	7/16	10¾	11 1/32	1·3750	3¾	20 3/32	21 21/32	1 9/16	¾

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ROTATING PLANT DIVISION, WITTON, BIRMINGHAM 6
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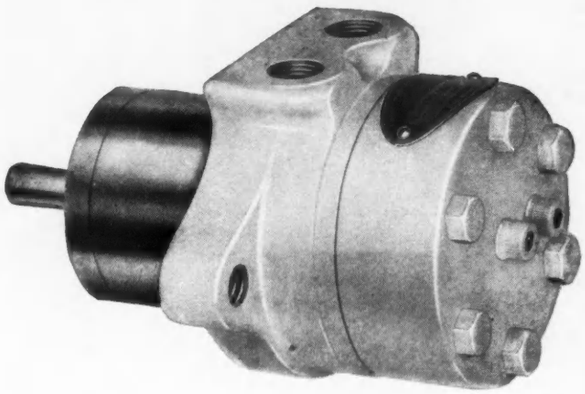

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The whole range of Savery Pumps is British made throughout. Let us know your requirements; our technical experts will be happy to make recommendations.

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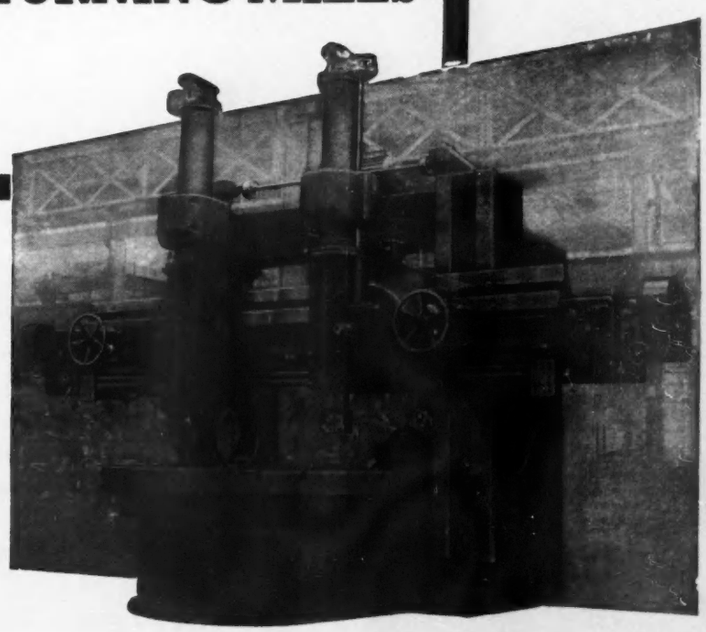
available for immediate delivery



These machines are of heavy construction, each with a 30 h.p. constant-speed table driving motor and a twelve-speed gear box. Feed traverse to each saddle and its ram is by an independent variable-speed motor, and additional constant-speed motors are used for all quick traverse movements.

Duplicate control stations give complete pushbutton operation of the main motor and full selection of the ram and saddle movements, including change-over from feed to quick traverse and vice versa, the various engagements being made by magnetic clutch operation.

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MACHINE TOOLS

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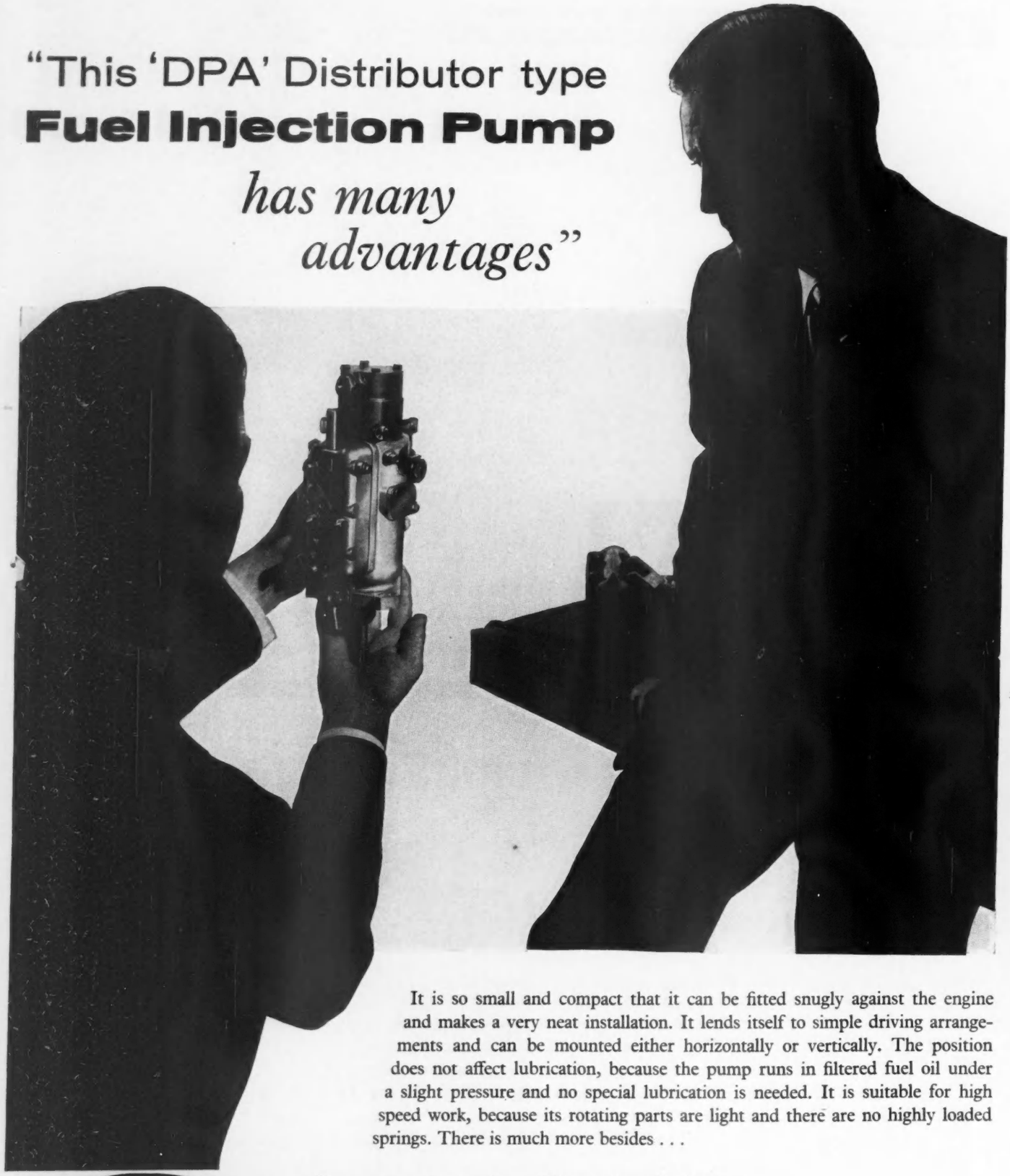
"This 'DPA' Distributor type
Fuel Injection Pump
has many advantages"



It is so small and compact that it can be fitted snugly against the engine and makes a very neat installation. It lends itself to simple driving arrangements and can be mounted either horizontally or vertically. The position does not affect lubrication, because the pump runs in filtered fuel oil under a slight pressure and no special lubrication is needed. It is suitable for high speed work, because its rotating parts are light and there are no highly loaded springs. There is much more besides . . .

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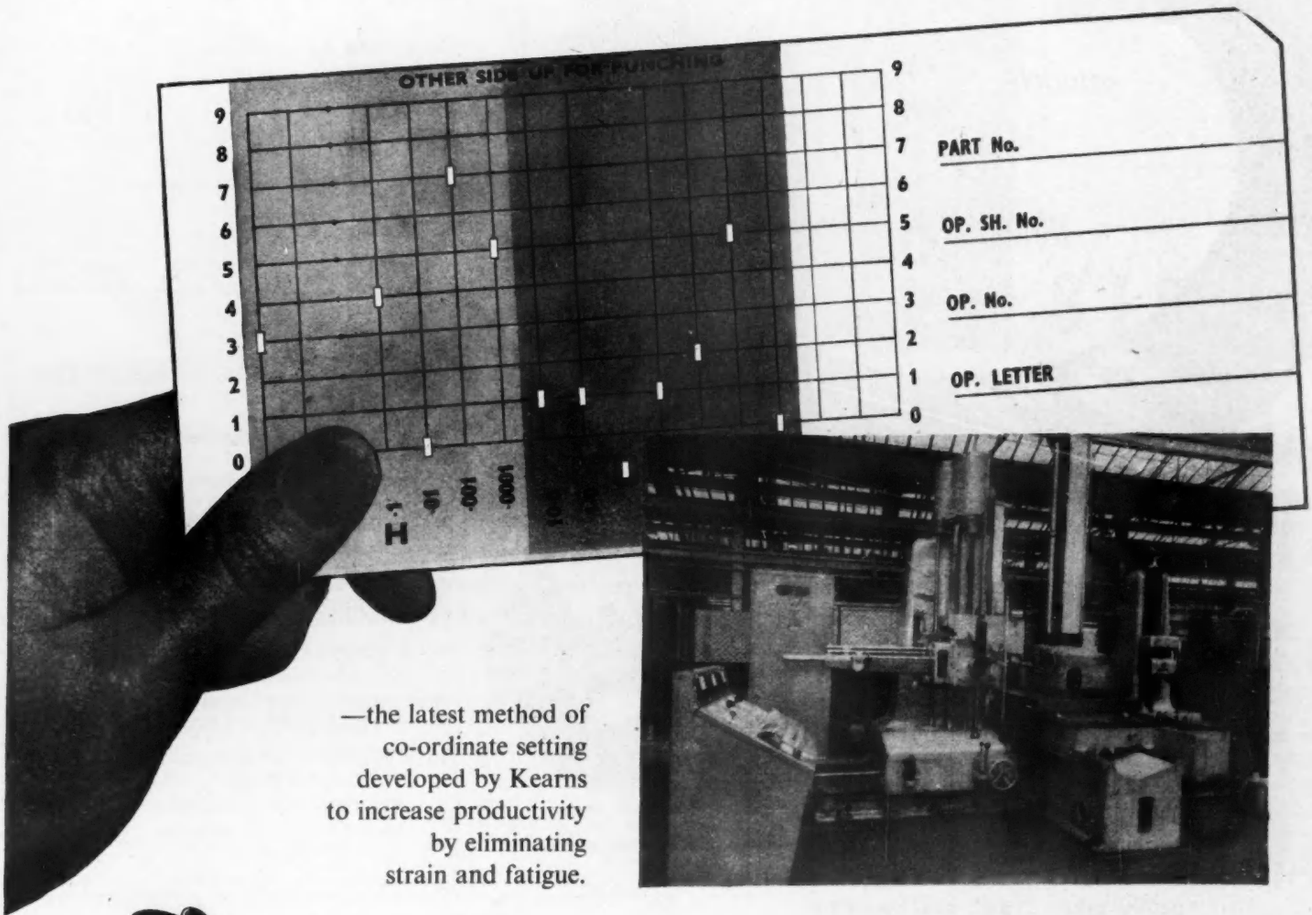

—the latest method of co-ordinate setting developed by Kearns to increase productivity by eliminating strain and fatigue.

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SALISBURY make most kinds of gears, axle shafts and transmissions for industry and commerce. And Salisbury technicians are always glad to co-operate on new projects and problems. Perhaps they can help you too? Please write for further details.

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This is an example of the special-purpose machinery which can be built to customers' specifications or designed by our own staff. Our production facilities — a combination of modern, well-equipped shops and a highly trained staff of craftsmen and technicians — enable us to produce high precision work to any dimensions.

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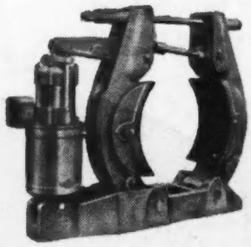

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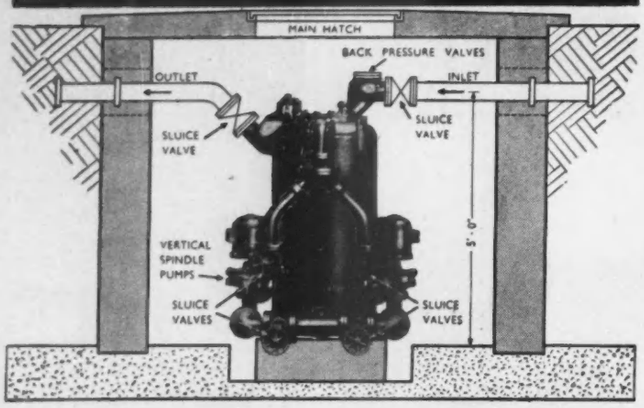

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Double Units capable of continuous inflow of 250 g.p.m.

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Recently developed are the two larger sizes, the patented principle of which makes them very suitable for discharging greater quantities against either low or unusually high heads, beyond the range of normal sewage pumps.

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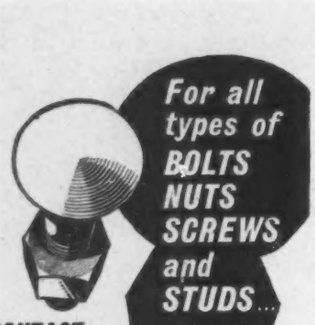

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"Marvellous!"

"Ever hear anything so smooth and solid?"

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"Makes the old feet tap, don't it?"

"W-e-l-l . . . I suppose it does"

"Never been a band like it"

"Band? I thought you were talking about the engines since we fitted L & C Piston Rings!"

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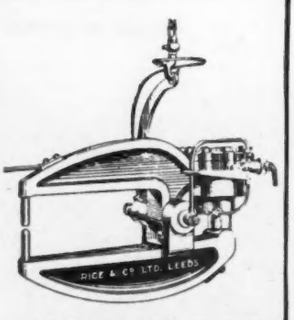

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1'-6" to 3'-6" Gap. 20 to 30 tons power.

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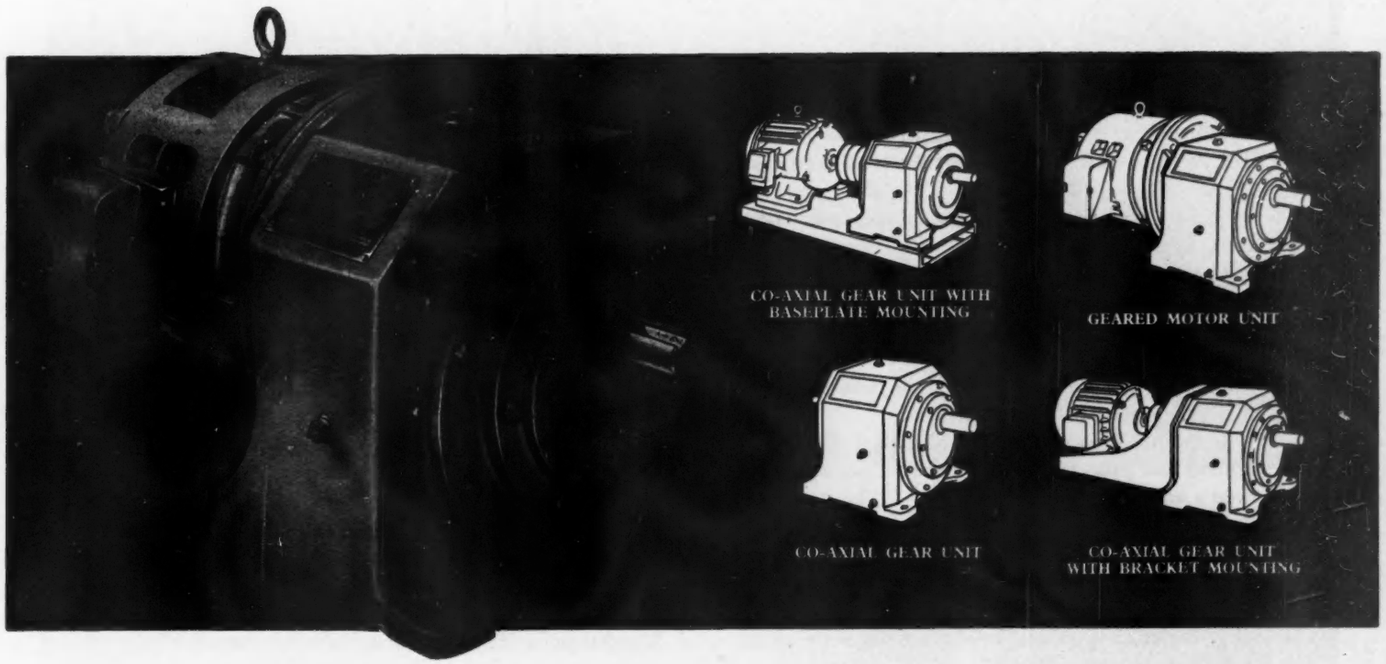
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So, with surprising similarity, does proper output from steam-heated plant.

Under practical conditions, process steam plant has air in it, at least to start with. The best place for that air is *outside*.

If air present mixes with steam, then your "steam"-pressure gauge can, by Dalton's Law, be making a fool of you and your best-laid production plans.

If the air is allowed to form pockets or films, these hamper heat transfer almost unbelievably. (All right, why wear a wool vest, then?)

Now, to solve these problems, you need to know whereabouts the air is, and how to expel it.

Its probable location is often a matter for experienced diagnosis, sometimes controversial. We are always ready to give specific help, and our two Information Sheets on the subject give general guidance.

Location established, the air can then be *automatically* expelled by a choice from the Spirax range of thermostatic air vents. These are designed and made to meet a practical problem which, unsolved, mocks sound engineering.

Our free postal instruction schemes on steam trapping and air venting go into the matter fairly thoroughly. Would you care for details?

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Please post . . . copies of "Air in Steam-Heated Plant."
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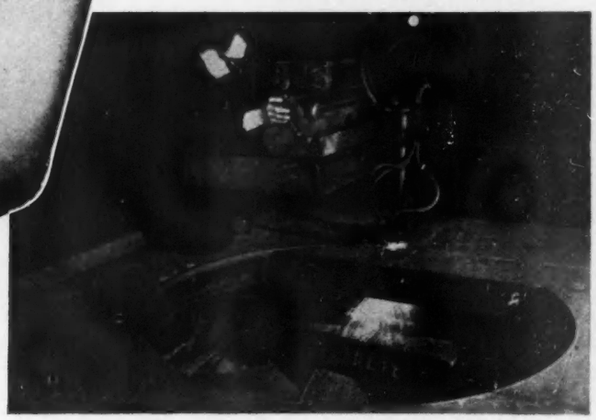

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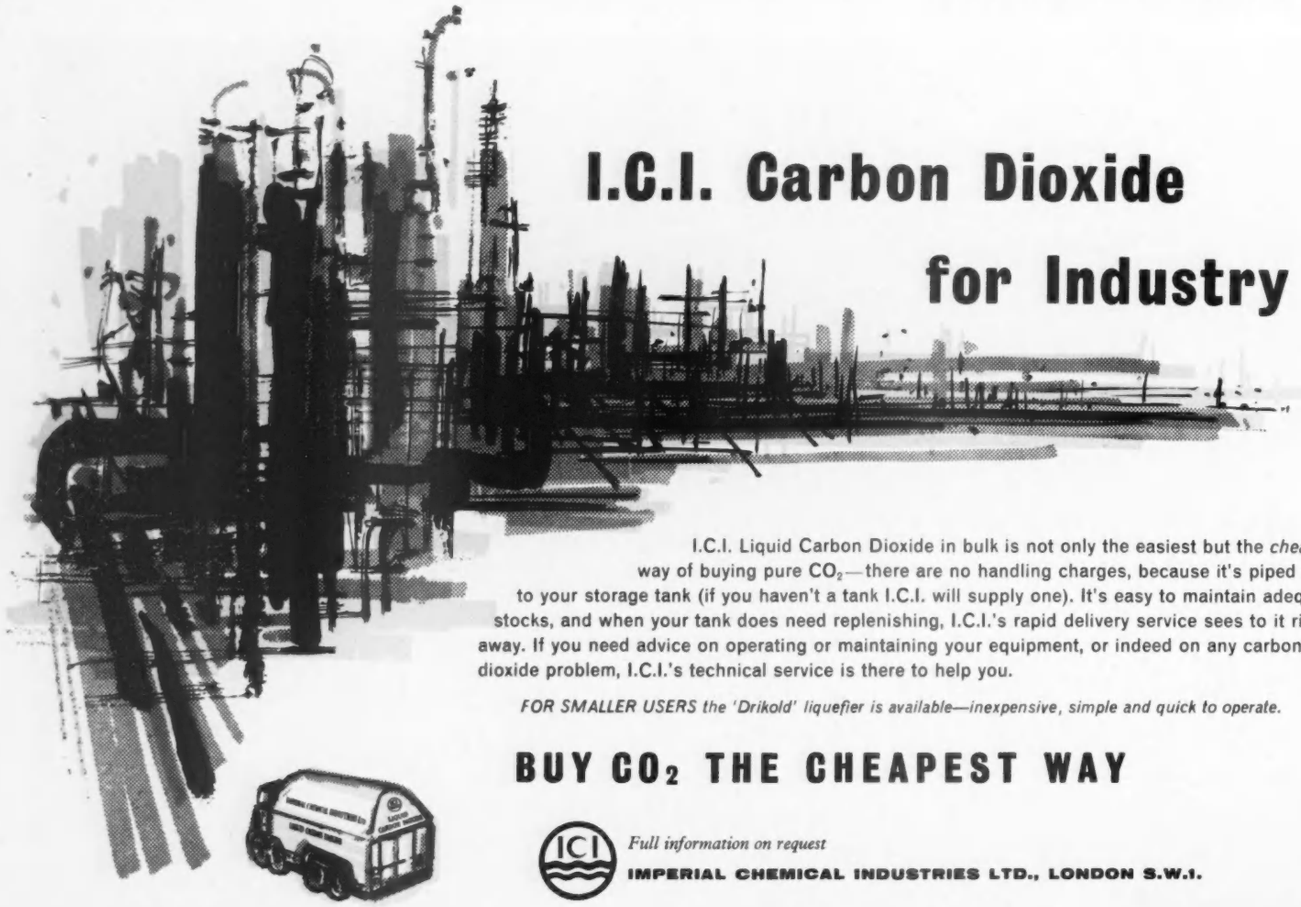

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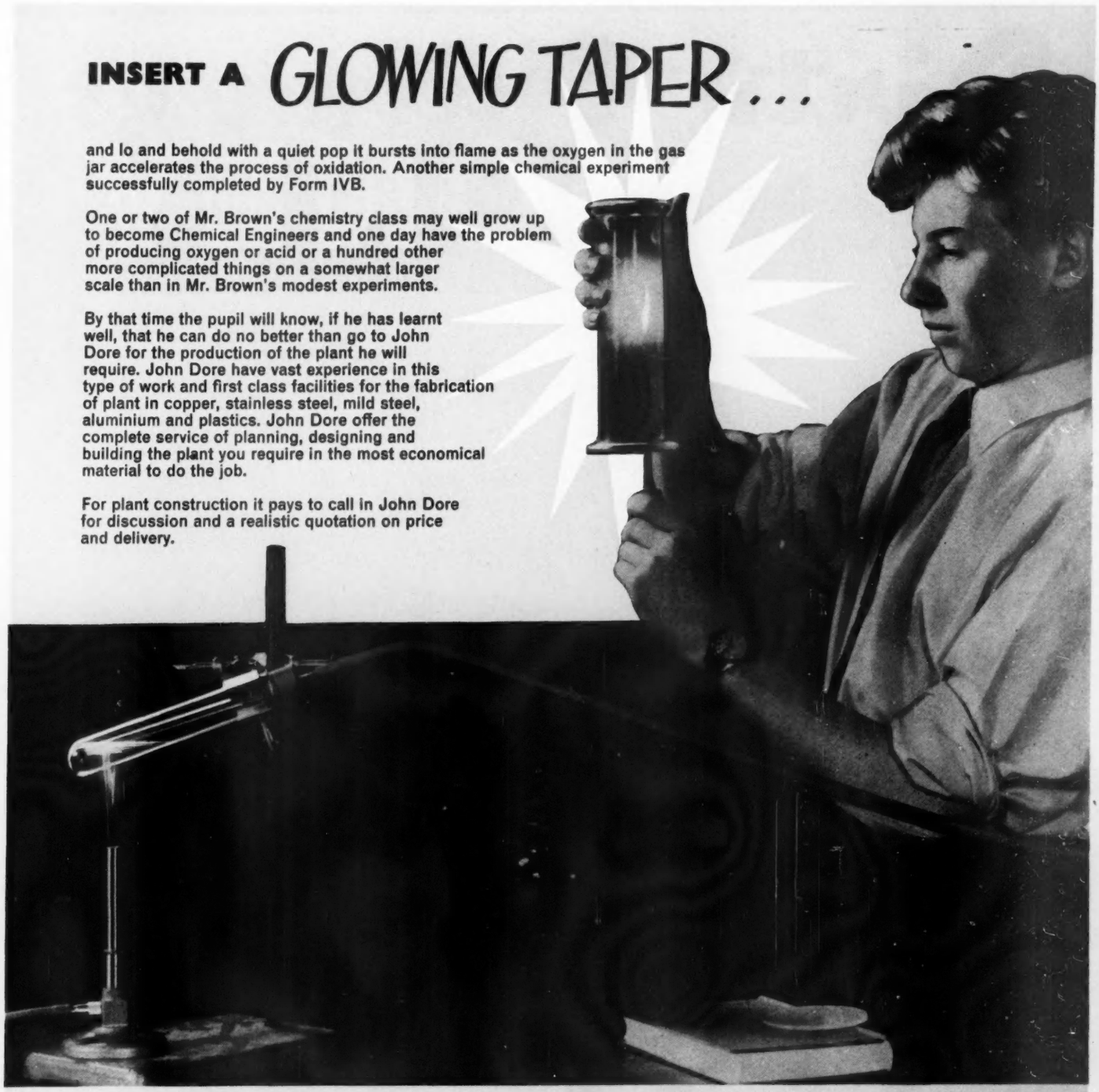

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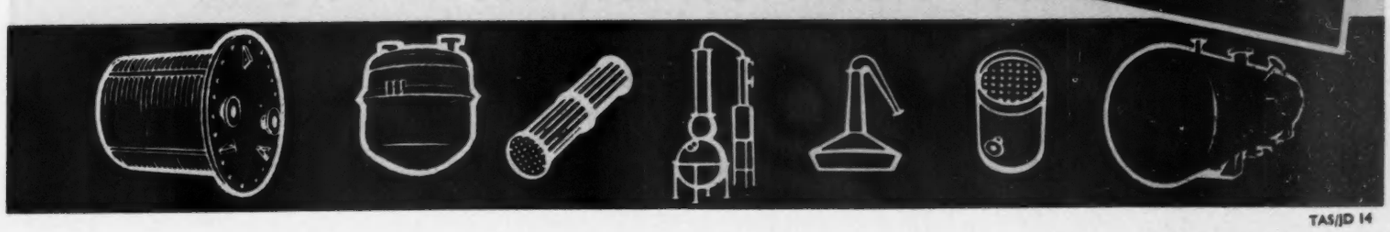

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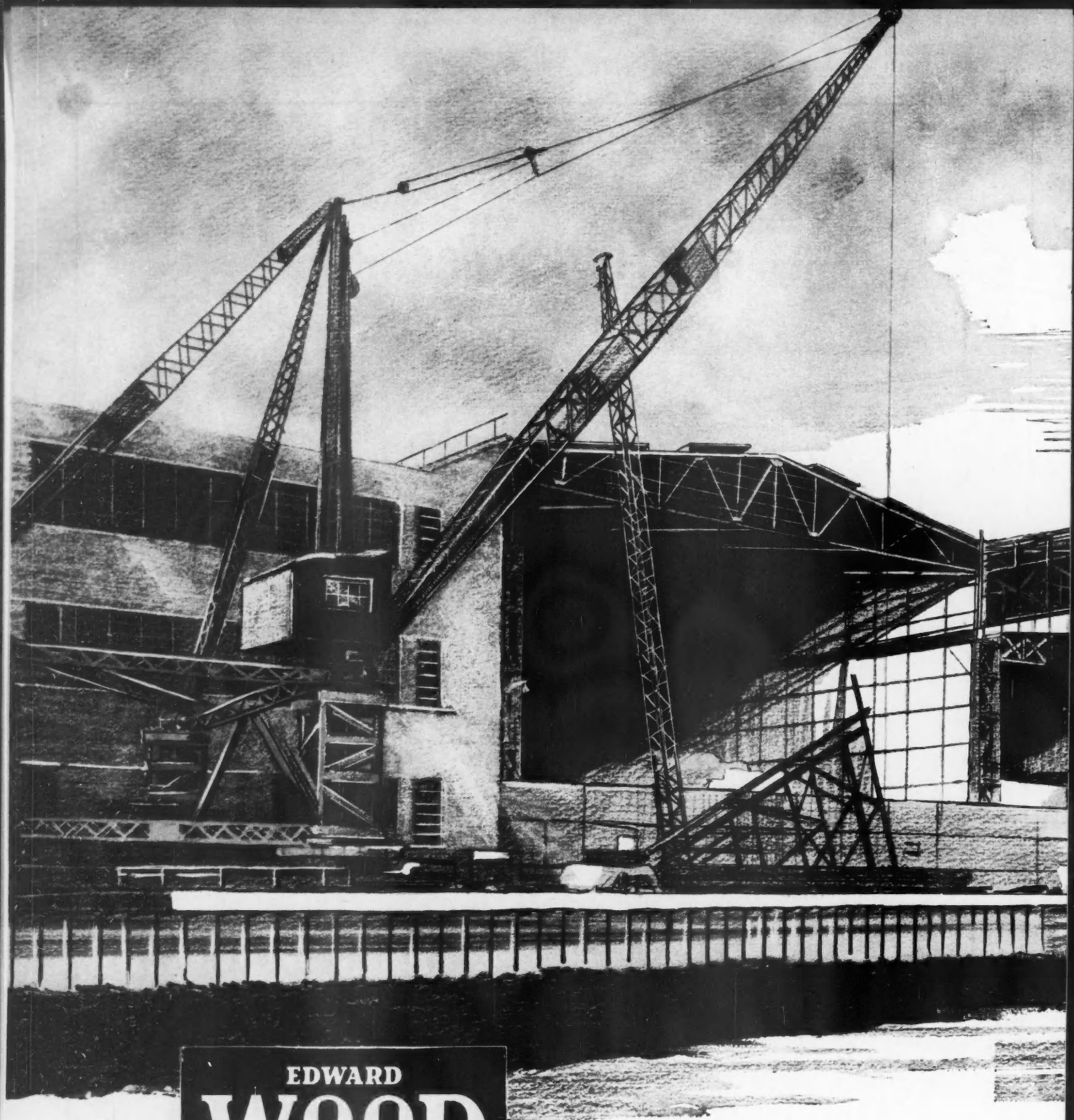

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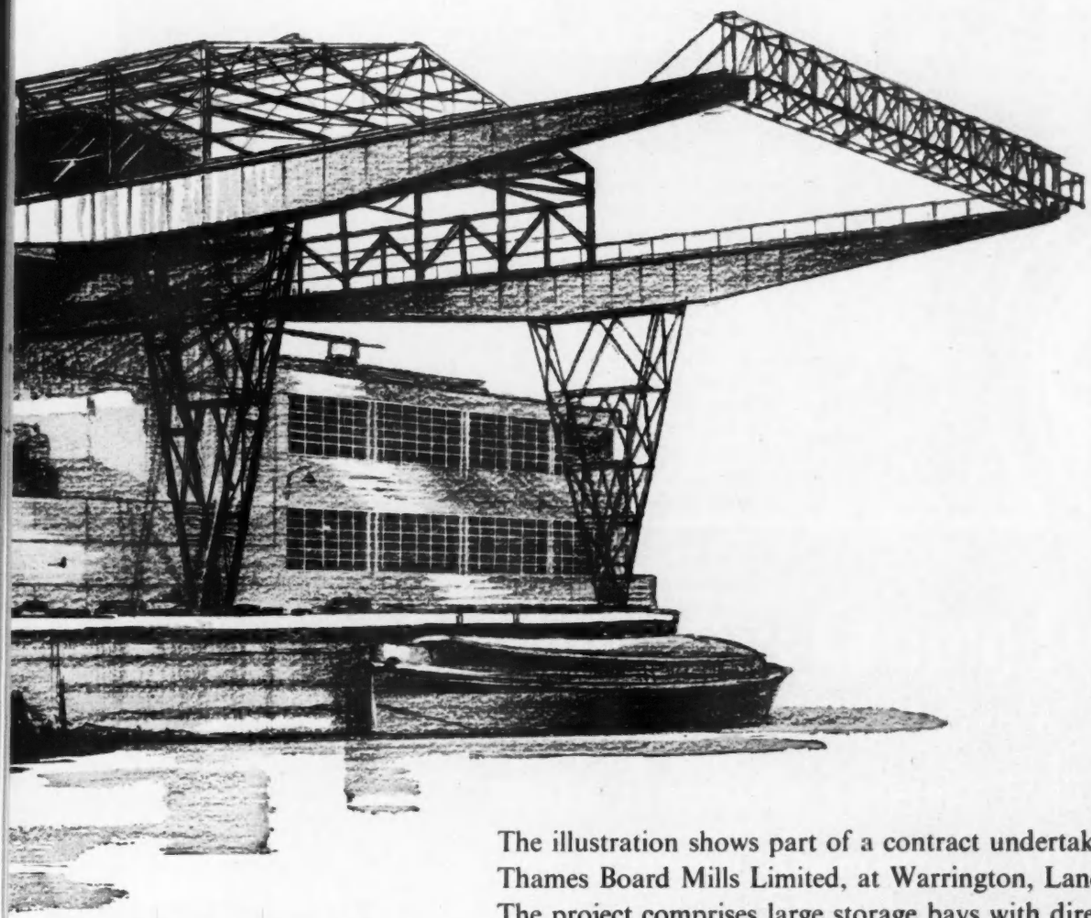

The illustration shows part of a contract undertaken for Thames Board Mills Limited, at Warrington, Lancashire. The project comprises large storage bays with direct loading facilities from the new diversion of the River Mersey at Arpley Meadows; the 50 ft. high gantry which will accommodate a travelling crane, has a 50 ft. projection over the quay side.

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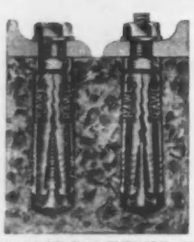
RAWLPLUG HEAVY DUTY FIXING DEVICES

RAWLBOLTS



Metal Expansion Bolts

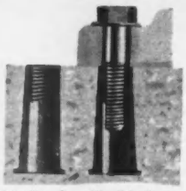
Loose Bolt Type

Bolt Projecting Type

LOOSE BOLT TYPE. For use where it is desirable or necessary to insert the bolt AFTER the Rawlbolt shield has been placed in position. These are usually preferred for floor fixings because there is no necessity to LIFT whatever has to be fixed either when installing or removing it. Moreover, if removed, NO projecting bolt is left in the floor.

BOLT PROJECTING TYPE. For use where it is desirable or necessary to have a bolt in position BEFORE whatever has to be fixed is offered-up into position. These are usually chosen for making firm fixings to a wall, because the item to be fixed can be SUSPENDED on the projecting bolt while the nut is put on and tightened. For overhead or ceiling work, either type of Rawlbolt is equally applicable.

When the Rawlbolt is inserted in the hole the action of turning the bolt causes the segments to be compressed against the wall of the hole completely locking the bolt and the fixture in position. There is no grouting in, therefore no waiting for cement to harden. Sizes for $\frac{1}{4}$", to 1" Whit Bolts.



CEMENT-IN SOCKETS

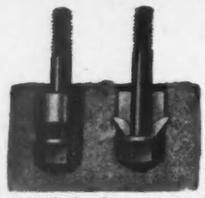
For fixing in-situ before cement is poured.

Made of malleable iron. They are placed in position before the cement is poured and remain permanent sockets to receive the bolts. To "spot" the Cement-in Sockets when fixed in the cement, a small wooden plug is usually inserted in the threaded hole and later removed. Sizes for $\frac{1}{4}$" to 1" Whit Bolts.

'H' TYPE TOGGLES

For use with standard carriage bolts where a heavy load has to be carried, and it is difficult or impossible to reach the reverse side of the wall for a through fixing. This device is the same in principle as a Gravity Type Toggle, but it is made especially for heavy duty work. A hole is bored right through the wall with a Rawltool. The 'H' Toggle is suspended horizontally towards the head of a bolt and pushed through the hole until it reaches the void where it falls into a vertical position. The fitting is inserted over the threaded end of the bolt and the nut tightened on so that it pulls the toggle tight against the back of the wall. Sizes for $\frac{1}{4}$" to $\frac{1}{2}$" Carriage Bolts.

Technical Literature Free on request.



CAULKING BOLT ANCHORS

This device is constructed from specially chilled iron in combination with lead. It is so formed that when caulked in position upon the head of a bolt, the chilled iron section forms a series of struts between the bolt head and the walls of the hole, making it impossible to withdraw the bolt until the walls of the hole break away or the bolt fractures. The method of use is to make a hole with a Rawlplug Tool, to place the bolt in the hole, head foremost, to place the washer on the bolt, and finally to follow with the Bolt Anchor, cone shaped head foremost. It is now ready for caulking which is carried out with a caulking tool and a heavy hammer. Sizes for $\frac{1}{2}$" to $1\frac{1}{2}$" Whit Bolts.

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for inserting a metal thread in shallow concrete.

A threaded steel sleeve on to which is pressed a cylinder of lead alloy to form a complete unit. A shallow hole of the correct size is made with the appropriate Rawldrill or Durium Drill, the Rawltamp is pushed to the bottom of the hole and given a few sharp blows with a hammer and the caulking tool; it is then ready to receive the bolt. Sizes for $\frac{1}{4}$" to $\frac{1}{2}$" Whit Bolts.

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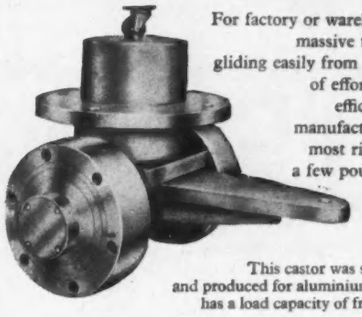

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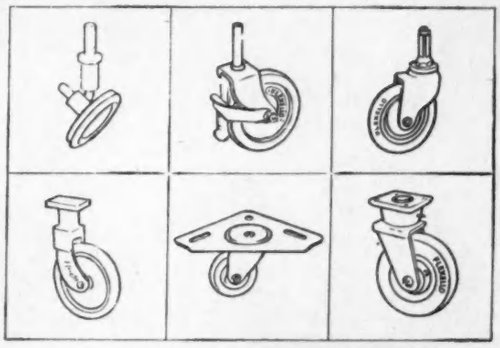

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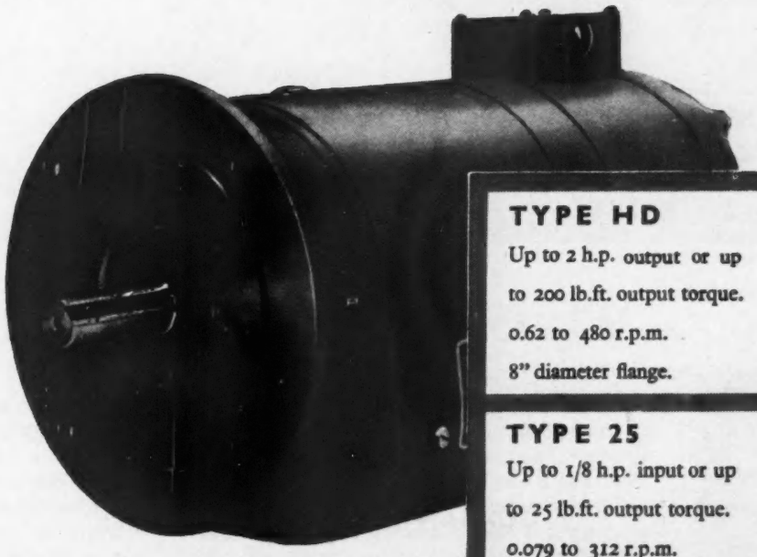

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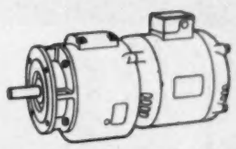

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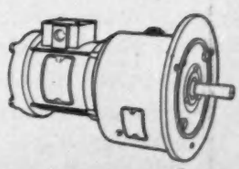

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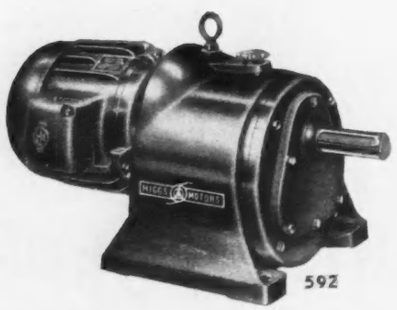

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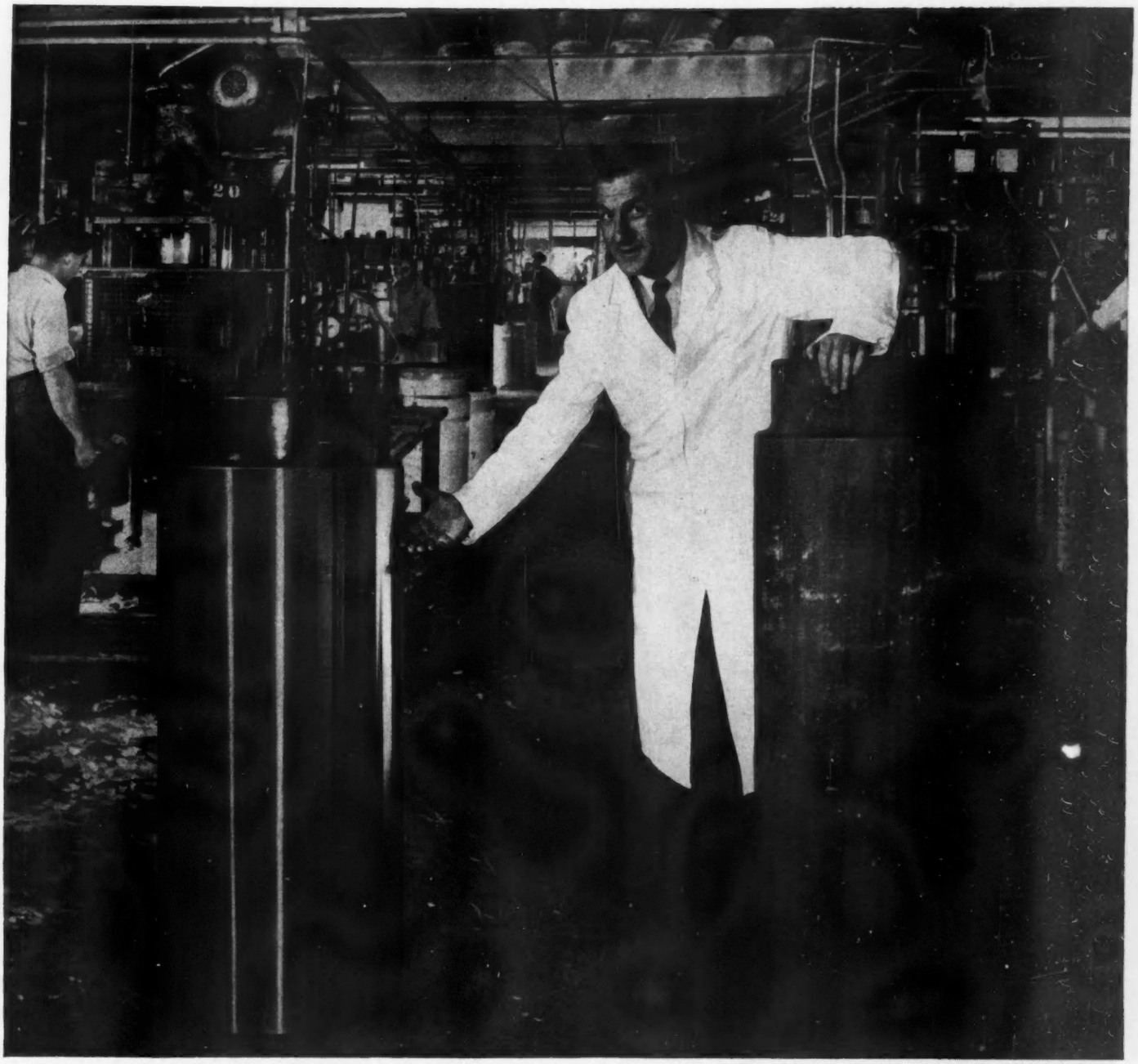

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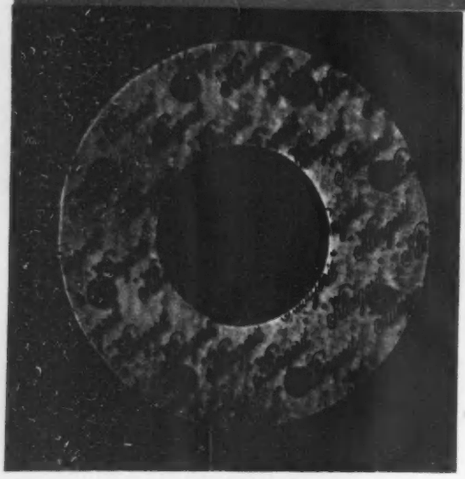

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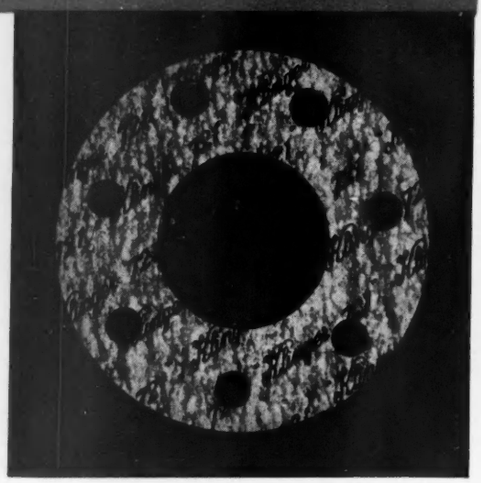

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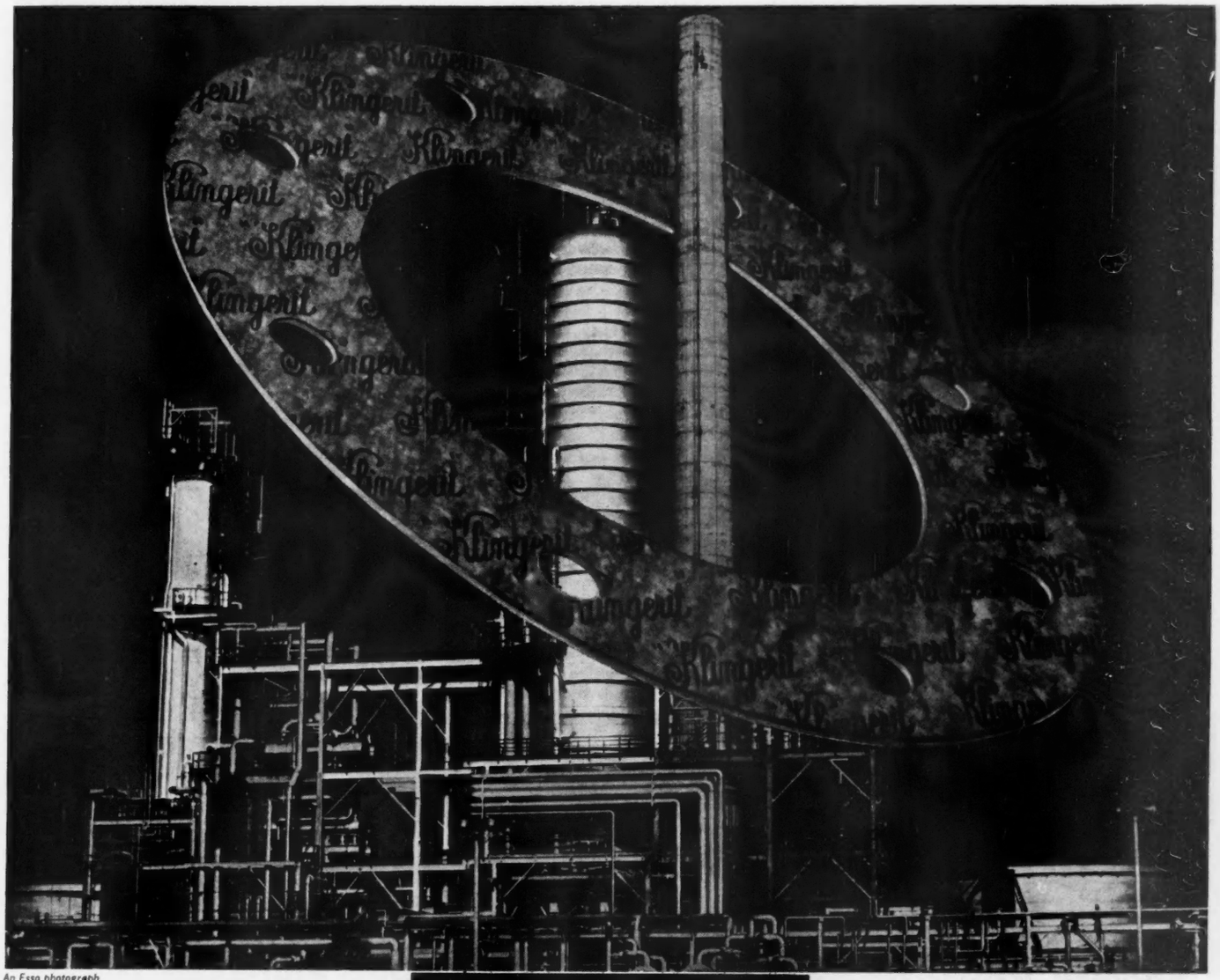

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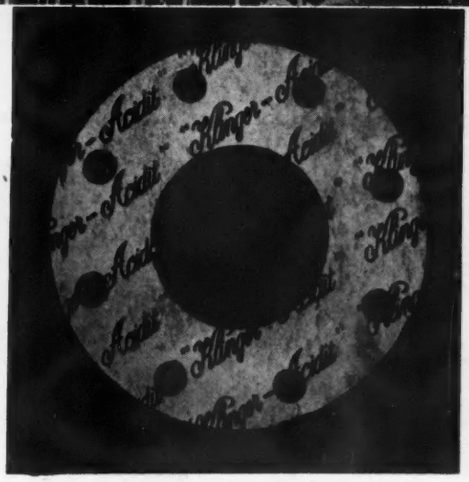

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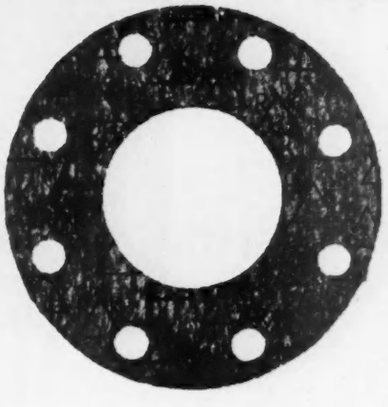

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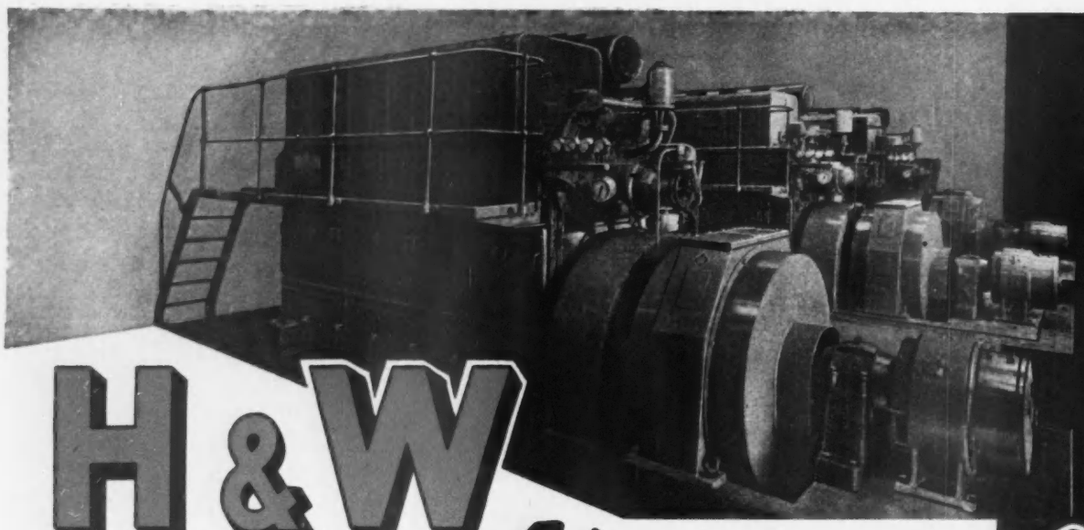

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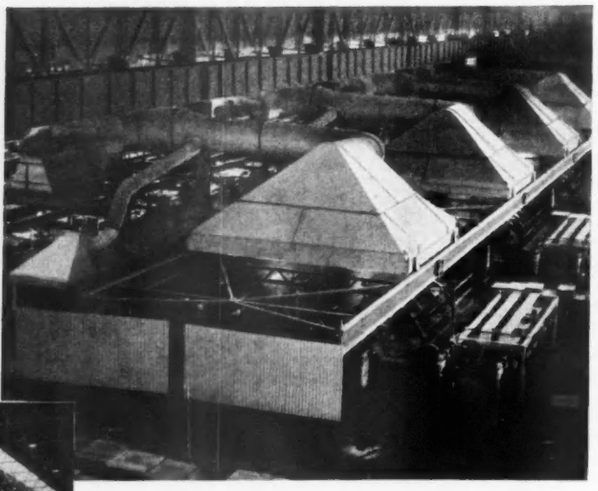

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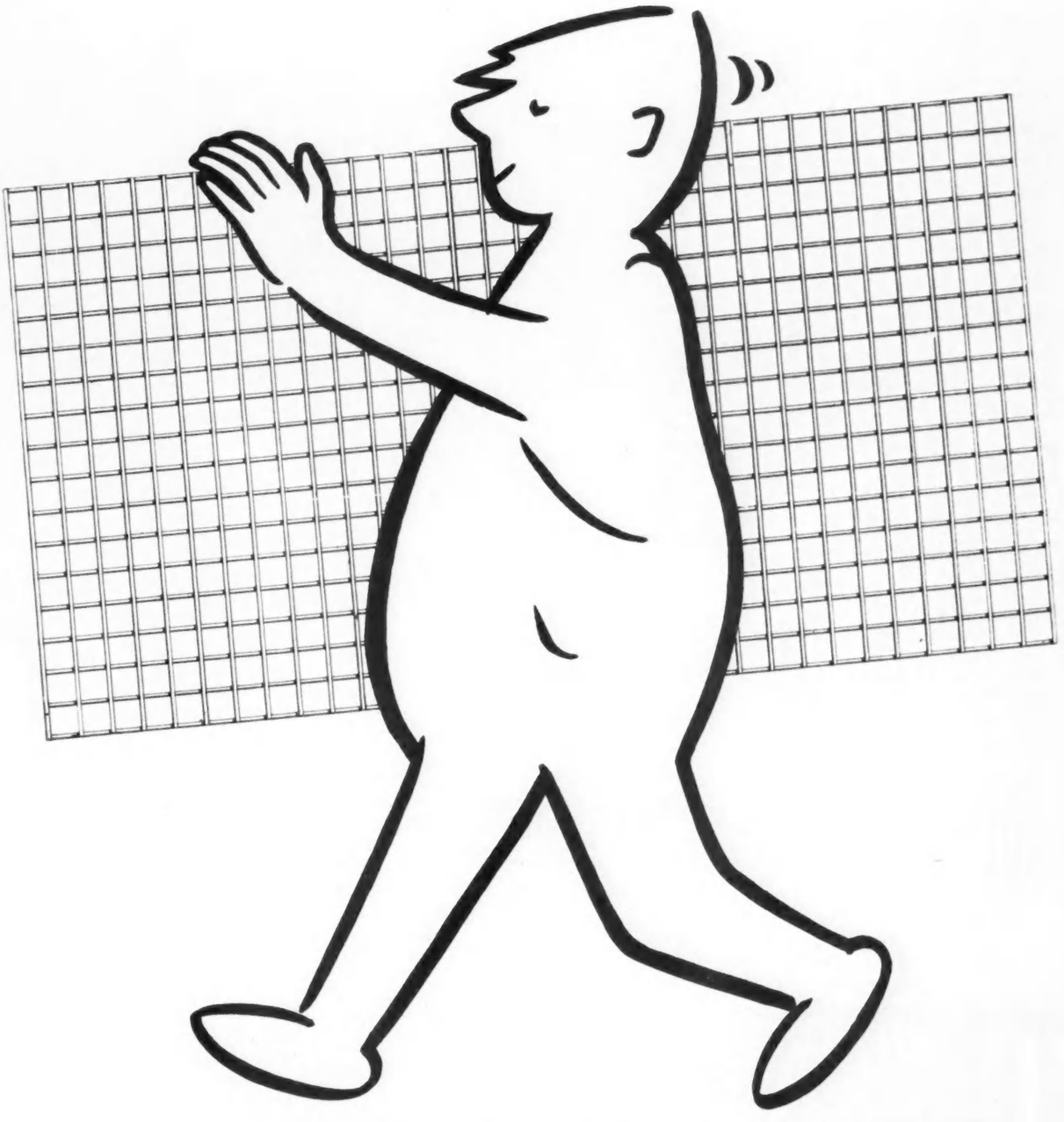

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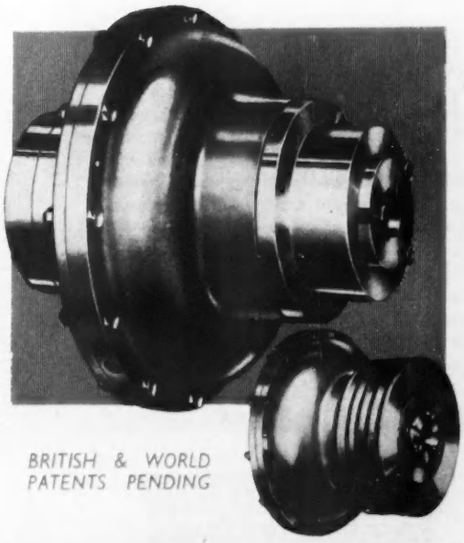

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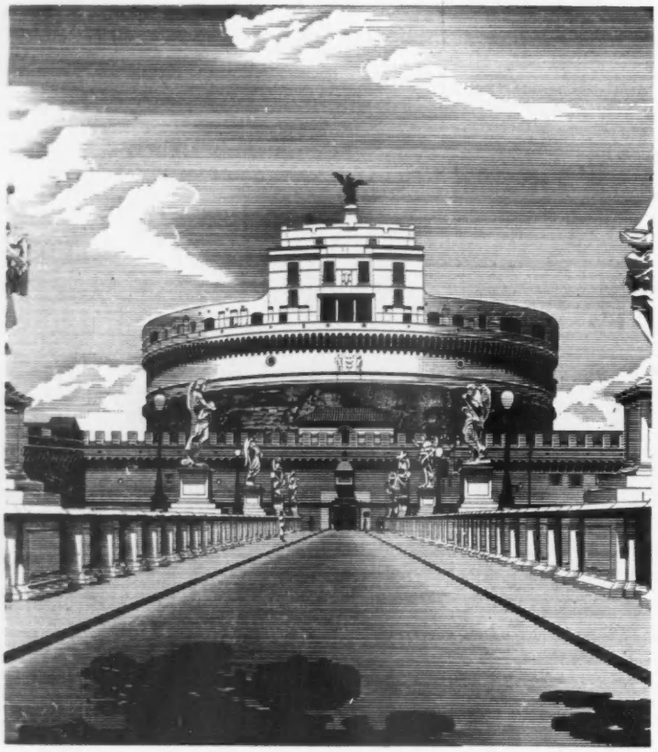

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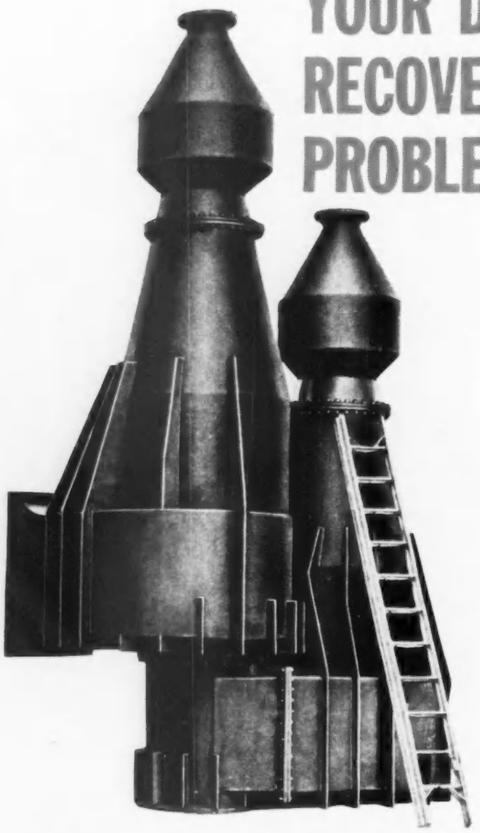

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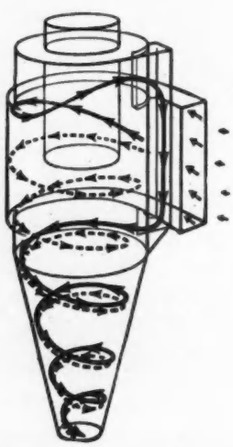

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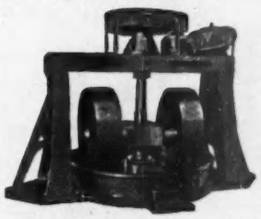

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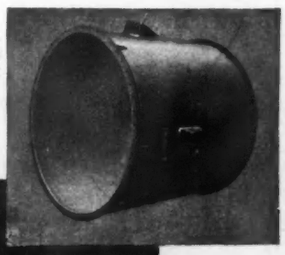

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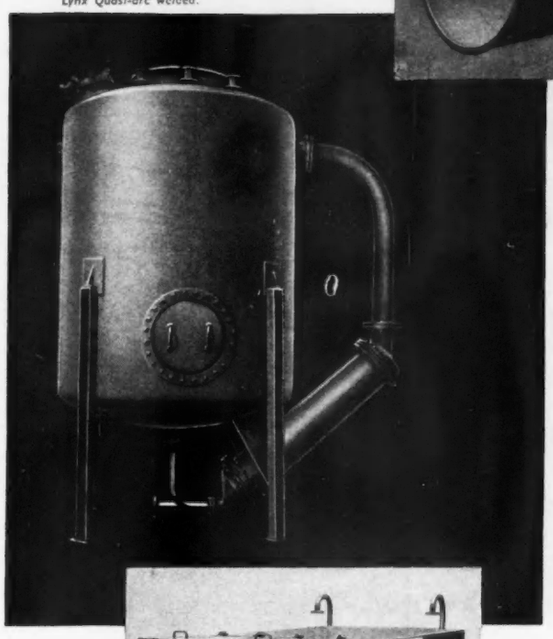

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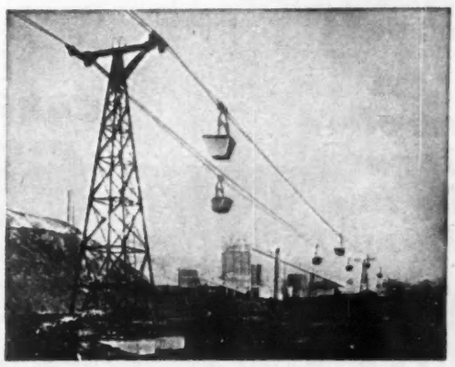

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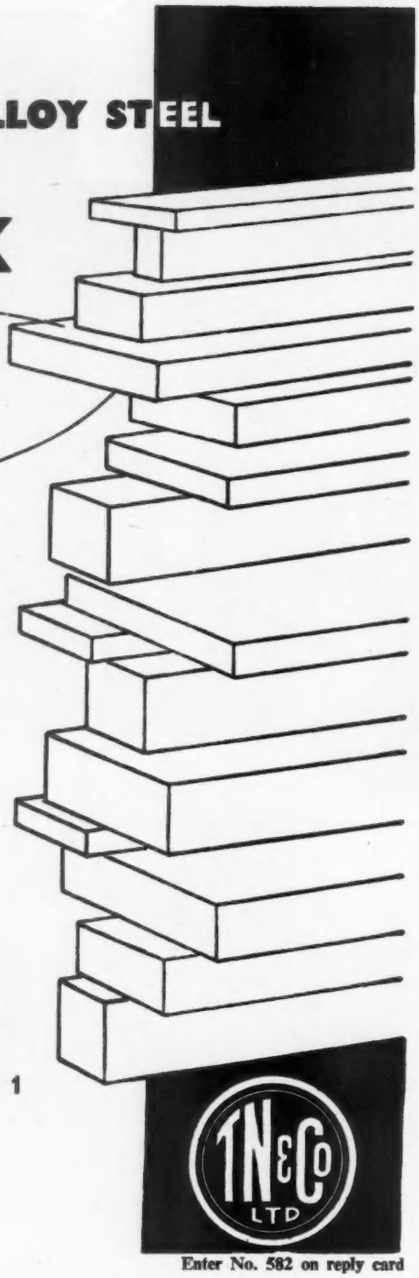

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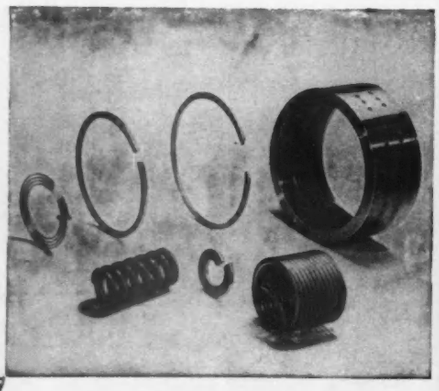

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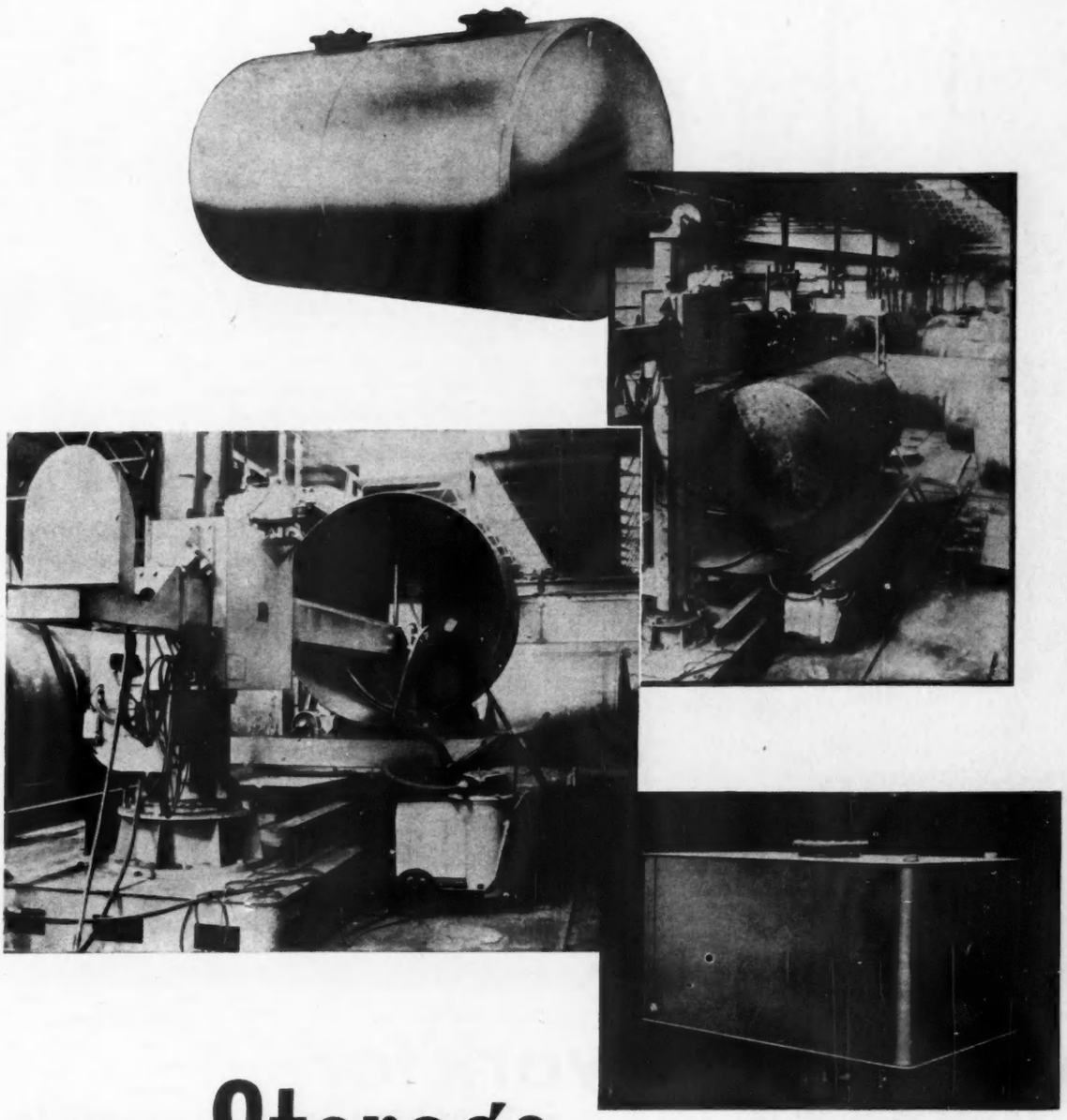

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THE ENGINEER

No. 5433 MARCH 11, 1960 VOL. 209

GUILLEBAUD AND BRITISH RAILWAYS

The main conclusion of the Guillebaud committee, whose report was published last Friday, is that, with certain exceptions, railway wages and salaries are 10 per cent lower than those of people doing comparable jobs in other industries. That conclusion was reached after many months of painstaking research in which the three-man committee was assisted by a team of investigating officers seconded for this particular task from various industrial undertakings. There is no doubt that the inquiry has been thorough. Some idea of the nature of the task can be gained when it is realised that the committee's officers submitted no less than 2200 separate reports relating to the exact nature of the work done by each railway grade and by grades of workers in other industries. The mass of information thus gathered then had to be analysed and collated before any useful conclusions could be drawn. The various factors affecting the general relativity of pay on the railways and in outside industries are the subject of one chapter of the report. They include such matters as hours of duty, overtime and week-end work, holidays and sick leave, superannuation contributions and benefits, career and promotion prospects, travelling facilities and security of employment for both salaried staff and manual workers. In some of these matters, comparison of the railways with other industries was difficult. But, after carefully weighing up all the factors, the committee has decided that, for the salaried staff, the advantages of railway employment approximately balance the disadvantages and that, by an increase of approximately 10 per cent in the general level of salaries, a " fair relativity " with outside employment would be achieved. When the conciliation grades are considered, however, the committee's view is that " the balance rests on the side of the advantages of railway employment." Taking into account the wage structure of the railways and that of other industries, the committee feels that an increase of approximately 8 per cent in the general level of rates would be involved if a " fair relativity " in relation to wage rates in outside industry is to be achieved.

From these broad conclusions, the committee goes on to deal in greater detail with the railway wage structure and with the difficult subject of " differentials." The circumstances surrounding railway wage negotiations in recent years have made it plain that differentials have been something of a stumbling block to the railway unions. At the outset of its investigations, the Guillebaud committee was confronted with the fact that, at present, there are over forty different rates of pay applicable to more than 150 grades of railway conciliation staff. Small wonder, therefore, that the committee takes the view that this wage structure needs radical simplification. The suggestion put forward appears a sound one ; it is that there should be a structure of twelve wage grades into which the existing large number of grades might be merged. There are six groups of conciliation staff which, the committee considers, merit special treatment within this wage structure. They are permanent way staff (other than labourers) ; shunters and head shunters ; passenger and goods guards ; signals and telecommunications staff (other than labourers) ; signalmen, and drivers and motormen (other than those engaged on shunting work). In its examination, the committee, unquestionably gave its most detailed consideration to these important groups, and it established that their wages were either " out of line " or " badly out of line " with the general run of railway pay, irrespective of comparison with wage levels in other industries. The proposal made in the report is that a differential of the order of 5 per cent, in addition to any general increase, might be appropriate to these groups, with the exception of the senior grades of signalmen and signals and telecommunications staff, for which the differential might be of the order of 10 per cent as their wages are considered to be " badly out of line." These are the main issues set out in the Guillebaud report. Alongside them, attention is drawn to a few other relevant matters. Among the latter is the suggestion that the negotiating machinery for salaried employees should be separated from that for manual workers ; such a step, the committee believes, would benefit industrial relations on the railways. Another matter which is touched upon is that some of British Railways' clerical procedures may be " unnecessarily elaborate." The committee thinks about this that the establishment of an " organisation and methods " section, independent of existing departments, would be helpful in reviewing clerical procedures.

The Guillebaud committee has thus completed its mammoth task. The results of its labours, as set out in the report, are before the parties which agreed that a comprehensive investigation of the railway wage and salary structure was essential. The parties, it must be noted, are the British Transport Commission and the three railway unions. They are now engaged in a careful study of the report and preliminary discussions between the Commission and the unions have begun. But the committee's suggestions, and it must be emphasised that they are suggestions, have naturally attracted much public attention. We believe that the public not only welcomes the results of this searching inquiry but approves the proposals that are made. Nevertheless, to make proposals is one thing, to implement them is another. More than the excellent work of the Guillebaud committee is necessary to raise the British railway system from the economic morass into which it has fallen in recent years. The railways were built up in an age in which they afforded a speedy and convenient alternative to slow-moving and uncomfortable horse transport. In that age, the railways were accounted as little short of the miraculous ! Nowadays, however, there are many instances in which road or air transport of people and goods has superseded that which can be achieved by the railways. In saying this, we are in no way discounting the technical progress made over the years throughout the British railway system, nor, of course, do we overlook the vast

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THE ENGINEER

No. 5433 MARCH 11, 1960 VOL. 209

GUILLEBAUD AND BRITISH RAILWAYS

The main conclusion of the Guillebaud committee, whose report was published last Friday, is that, with certain exceptions, railway wages and salaries are 10 per cent lower than those of people doing comparable jobs in other industries. That conclusion was reached after many months of painstaking research in which the three-man committee was assisted by a team of investigating officers seconded for this particular task from various industrial undertakings. There is no doubt that the inquiry has been thorough. Some idea of the nature of the task can be gained when it is realised that the committee's officers submitted no less than 2200 separate reports relating to the exact nature of the work done by each railway grade and by grades of workers in other industries. The mass of information thus gathered then had to be analysed and collated before any useful conclusions could be drawn. The various factors affecting the general relativity of pay on the railways and in outside industries are the subject of one chapter of the report. They include such matters as hours of duty, overtime and week-end work, holidays and sick leave, superannuation contributions and benefits, career and promotion prospects, travelling facilities and security of employment for both salaried staff and manual workers. In some of these matters, comparison of the railways with other industries was difficult. But, after carefully weighing up all the factors, the committee has decided that, for the salaried staff, the advantages of railway employment approximately balance the disadvantages and that, by an increase of approximately 10 per cent in the general level of salaries, a " fair relativity " with outside employment would be achieved. When the conciliation grades are considered, however, the committee's view is that " the balance rests on the side of the advantages of railway employment." Taking into account the wage structure of the railways and that of other industries, the committee feels that an increase of approximately 8 per cent in the general level of rates would be involved if a " fair relativity " in relation to wage rates in outside industry is to be achieved.

From these broad conclusions, the committee goes on to deal in greater detail with the railway wage structure and with the difficult subject of " differentials." The circumstances surrounding railway wage negotiations in recent years have made it plain that differentials have been something of a stumbling block to the railway unions. At the outset of its investigations, the Guillebaud committee was confronted with the fact that, at present, there are over forty different rates of pay applicable to more than 150 grades of railway conciliation staff. Small wonder, therefore, that the committee takes the view that this wage structure needs radical simplification. The suggestion put forward appears a sound one ; it is that there should be a structure of twelve wage grades into which the existing large number of grades might be merged. There are six groups of conciliation staff which, the committee considers, merit special treatment within this wage structure. They are permanent way staff (other than labourers) ; shunters and head shunters ; passenger and goods guards ; signals and telecommunications staff (other than labourers) ; signalmen, and drivers and motormen (other than those engaged on shunting work). In its examination, the committee, unquestionably gave its most detailed consideration to these important groups, and it established that their wages were either " out of line " or " badly out of line " with the general run of railway pay, irrespective of comparison with wage levels in other industries. The proposal made in the report is that a differential of the order of 5 per cent, in addition to any general increase, might be appropriate to these groups, with the exception of the senior grades of signalmen and signals and telecommunications staff, for which the differential might be of the order of 10 per cent as their wages are considered to be " badly out of line." These are the main issues set out in the Guillebaud report. Alongside them, attention is drawn to a few other relevant matters. Among the latter is the suggestion that the negotiating machinery for salaried employees should be separated from that for manual workers ; such a step, the committee believes, would benefit industrial relations on the railways. Another matter which is touched upon is that some of British Railways' clerical procedures may be " unnecessarily elaborate." The committee thinks about this that the establishment of an " organisation and methods " section, independent of existing departments, would be helpful in reviewing clerical procedures.

The Guillebaud committee has thus completed its mammoth task. The results of its labours, as set out in the report, are before the parties which agreed that a comprehensive investigation of the railway wage and salary structure was essential. The parties, it must be noted, are the British Transport Commission and the three railway unions. They are now engaged in a careful study of the report and preliminary discussions between the Commission and the unions have begun. But the committee's suggestions, and it must be emphasised that they are suggestions, have naturally attracted much public attention. We believe that the public not only welcomes the results of this searching inquiry but approves the proposals that are made. Nevertheless, to make proposals is one thing, to implement them is another. More than the excellent work of the Guillebaud committee is necessary to raise the British railway system from the economic morass into which it has fallen in recent years. The railways were built up in an age in which they afforded a speedy and convenient alternative to slow-moving and uncomfortable horse transport. In that age, the railways were accounted as little short of the miraculous ! Nowadays, however, there are many instances in which road or air transport of people and goods has superseded that which can be achieved by the railways. In saying this, we are in no way discounting the technical progress made over the years throughout the British railway system, nor, of course, do we overlook the vast

programme of modernisation which is now being vigorously pressed forward. Moreover, we can find no shred of disagreement with the Guillebaud committee's conclusion that improvement in railwaymen's pay is overdue. Yet the question that arises is obvious. How can the proposals, if implemented, be financed, when they are considered, as they must be, alongside the hundreds of millions required to complete the modernisation plan and alongside the accumulating deficit which the British Transport Commission is compelled to report ? The Guillebaud proposals make imperative another appraisal of the future of British Railways. Such an appraisal would surely include, as we suggested in these columns on January 22, the speedier abandonment of a whole crop of unremunerative branch lines and a ruthless determination to be rid of all thoroughly unprofitable transactions. After the interim settlement of the railway wage dispute just over a month ago, when a 5 per cent increase " on account " was granted, there were indications that the Government was attempting to find a way which might help to correct the deteriorating financial state of the railways. As we go to press, a Government statement on the subject is imminent. That statement, we hope, will do something towards clarifying a situation which, despite the excellence of the Guillebaud committee's work, is rather dismal.

Lastly it is necessary to consider the possible effects of the report in the wider context of wage rates in general. At the annual general meeting of the British Employers' Confederation last Tuesday its president, Sir William Garrett, voiced certain fears. The Confederation, he said, " views with some disquiet the possibility that any settlement which may be achieved in the railway service as a result of the review conducted by Mr. Guillebaud may be used as a pretext in other industries to re-establish the differentials between earnings in those industries and in the railway service . . . ." The effect could not, obviously, be other than inflationary. If, as Sir William put it, " the Government has to resort to counter-inflationary methods it will be on employers that the brunt will first fall . . . In these circumstances it is incumbent on employers to do all that lies within their powers to avoid the necessity for such measures arising."

BARRAGE AND BARRIER THAT NOBODY WANTS ?

The Ministry of Housing and Local Government has at last published a summary of the recommendations for the " flood barrier," as it is called, across the Thames at Long Reach. Details are given on page 430 of this issue : stated very briefly the idea is that, should an exceptional tidal surge occur in the North Sea, sufficient warning would be given to close the gates of the barrier (which are normally open with virtually no interference to river flow), some hours before the surge penetrated the estuary, and thus keep the peak river levels in the London area within safe limits. First of all, it should be pointed out that the technical problems which this idea presents are both novel and severe. The two consulting firms concerned are clearly to be commended for the ingenuity and skill exhibited in the designs which they propose, and for the clarity with which the problems of the barrier are discussed. Within the limits of their terms of reference, a businesslike engineering solution has been shown to be feasible, and one which, if the structure were built, would arouse considerable interest and be a major engineering achievement.

It is, however, the broader issues (outside the consultants' terms of reference) discussed by the technical panel, which have not been resolved so satisfactorily, and about which indecision is still evident, six years or so after the idea was first propounded as a matter of some urgency by the Waverley committee. A lack of precision is evident in the panel's estimates of the future occurrence of surges. A level of 6ft above that of 1953 is specified for the barrier, but there is no evidence given as to why this level was chosen. Indeed, it is not critical to the success of the barrier that this level should be stated with great precision, but it is important if some sort of economic appraisal is to be made to justify the construction of the barrier. By comparison, the Dutch sea defences of the Delta plan are better served. It has been calculated that the 1953 levels have a probability of occurrence on the Dutch coast of once in four centuries. Increased surge height and river flows giving levels of around 1m higher than 1953, have been accepted as a standard for defence works, their probable frequency of occurrence being estimated as once in 10,000 years. What is the probable frequency of occurrence of a level 6ft higher than the 1953 level at Long Reach ? Given an answer to this question, a sort of actuarial statement balancing the cost of the barrier against possible flood damage would doubtless prove illuminating. It is common practice, at least in the U.S.A., to tot up profit and loss accounts for flood protection works. In this case, would the risk of flooding be the lesser of two evils ? Is it not quite possible that the barrier would never have to be closed throughout the course of its useful life ?

Another argument, on an even broader basis, presents itself insistently at this stage. The panel states " It has not been considered that our terms of reference include examination of the suggestion previously advanced by the Thames Barrage Committee for a permanent barrage across the river. The proposal to build a barrage which would permanently impound the river on its upstream side raises issues and affects interests much wider than those we have had to consider in dealing with a movable structure, the latter being quite different in purpose and conception from a barrage." We would respectfully suggest that it is precisely these wider issues which need to be satisfactorily resolved before an expensive project like the barrier is undertaken. It is well known that the more successful river developments are based on " multi-purpose " concepts ; power generation, flood protection and so on, are best not considered in isolation. In the case of the Thames, we have an unusual and complicated case of a river on which the primary activity is navigation, but which is at the same time a major feature in the character of London, and has many economic uses, some active, some potential. It would, therefore, be a mistake to construct flood defences without adequate consideration of all possible alternatives. The Thames barrage scheme is one such alternative. It would seem that the interests of navigation could, in principle, be served equally well by such a barrage, as by a " barrier " with two 500ft main openings. The critical engineering problem for the barrage, however, is that of silting. When tidal penetration in an estuary is artificially stopped by a dam or weir, silting results downstream. It would be necessary to make a quantitative appraisal of this effect, and of any expedients which could be devised to mitigate it. It seems fairly clear that this problem is not decisive ; if it were, the panel would have said so. Thus we are not asserting that the " barrage " is the ideal solution. Our point is that at the present stage of deliberations a thorough investigation of its possibilities is called for and that without it a proper evaluation of the barrier cannot be reached. A much more precise evaluation of the barrage needs to be made, bringing to bear those same creative qualities that we have seen

exercised in the three designs for the "barrier." By comparison, the barrage idea is no more at present than a sketch on the back of an envelope. Economic studies alone would cover a very wide field, as we have indicated in earlier comments on this idea. But it would be just and proper to set them in comparison against the "barrier" project. In any case, the "barrier" itself is being sponsored by the Ministry with such a lack of haste that it seems dubious whether anyone really wants to see it constructed.

INCOMES OF PROFESSIONAL MEN

It may not seem at first sight very likely that engineers will find much to interest them in the Report of a Royal Commission on Doctors' and Dentists' Remuneration. But that report contains tables comparing the level of doctors' and dentists' remuneration with that of people in other professions, including engineering. It thus becomes possible to compare the incomes of engineers with those of medical consultants, actuaries, general medical practitioners, dentists, barristers, solicitors, university teachers, chartered accountants, and surveyors, all of whom, more or less in the order listed, are better off than engineers, and architects who do less well. A table condensed from more complete information in the report will be found on page 436 of this issue. The lowly situation of engineers in the list seems decidedly unsatisfactory in relation to the services they perform for the public.

The figures given for engineers are identical with those published about five months ago by the Engineers' Guild. We commented at that time that though the impression was certainly given by the figures that engineers' earnings were unduly low it would be necessary to obtain more information than was then available to find out exactly what the figures did imply. Some of that additional information is now made available by the publication of the Commission's report. But we confess we still remain a little puzzled. The figures, of course, relate to 1955–56 and it can be assumed that there will have been a quite substantial upward revision of engineers' salaries since then ; but that upward revision will have applied to the other professions too, so that there is no reason to suppose that there has been any change of relative positions since then. The puzzling feature is that, coincident with a period when engineers' earnings appear to be relatively low, there is a strong demand for engineers. We understand that the Guild is now, by itself, undertaking a more up-to-date review of engineers' salaries and earnings. If so it is to be hoped that it will try to illuminate the stituation more fully by entering into more detail than has been revealed by the present investigation.

The sample of engineers upon whose remuneration the tables are based was drawn from corporate members of the Institutions of Civil, Mechanical, and Electrical Engineers. A particular point which seems to merit investigation relates to the academic attainments of the engineers concerned. The relevance of that suggestion is made evident by a table in the report giving particulars of the incomes of a substantial sample of graduates employed by certain selected large industrial and commercial undertakings. Their incomes, it turns out, correspond closely in level throughout the higher age groups in both the quartiles and the median with those of general medical practitioners, a much more satisfactory result. A substantial proportion of those graduates must surely be engineers. There is, therefore, a quite strong suggestion that the incomes of university-trained engineers are satisfactory enough, but that many of those who have gained entry into the Institutions through National Certificate courses or in other ways may be less highly valued by industry and unable to command such high salaries. Another possible reason for the unsatisfactory showing of engineers' incomes by comparison with those in other professions may lie in the inclusion within the qualification conferred by Institution membership of men with a much wider range of intellectual and practical ability than is to be found elsewhere, as, for example, in medicine. The Guild should be well placed to investigate the real situation. Possibly some illumination could be offered at once by the Professional Engineers' Appointments Bureau which must by now have a close estimate of the kind of salary level corresponding to age, qualifications and experience likely to be offered to candidates for jobs. Now that the Bureau is under the control of the Guild, that body could ask for the information without impropriety.

BRITISH STEEL

Over the past twelve months British steel production has been steadily mounting, following the decline in output and demand which was evident throughout 1958. As we go to press, the steel production figures for the month of February have just been announced. They show that the output of steel ingots and castings averaged 482,200 tons a week, which indicates an annual production rate of 25,073,000 tons. Thus, the steel industry which, in the years since the war, has pressed on vigorously with modernisation and expansion plans, has achieved a record of which it can deservedly be proud. We learn from the British Iron and Steel Federation that the February output shows that the industry is now working to approximately 98 per cent of its installed capacity. The Federation says also that an annual rate of 25,000,000 tons in February is a reliable indication that a total output for the year of 24,000,000 tons will be reached.

The Engineer—100 Years Ago (MARCH 9, 1860)

"DEFENCE OF THE THAMES"

"A meeting was held at the London Tavern last week for the purpose of appointing a committee to consider the 'best and most available means for securing efficient protection to the great interests and immense wealth of the metropolitan district.' A model and several drawings, plans, and sections of Mr. W. J. Hall's impregnable iron fortress, to be erected, if approved of, at the Nore, were exhibited, on a scale of a quarter of an inch to the foot. From these, it appeared that the proposed fortress is to be in the shape of a round tower, diminishing in diameter towards the summit at the rate of 1 inch to the foot. It is to be 235ft. high, and 126ft. in diameter at the base. An air-shaft, 20ft. in diameter, runs from top to bottom. A spiral staircase is constructed around this shaft, leading to 11 floors or compartments, each having 32 windows and a door. At the top is the sleeping room ; the next floor is the officers' mess room. One compartment is devoted to the steam engine and boiler, and six lifeboats. There is also a room appropriated to shot and shell, and the powder magazine is placed below the water mark. There is to be a lighthouse at the top, 12ft. in diameter, which can be raised or lowered by a telescope slide, as the circumstances of peace or war may require. The air-shaft is surrounded by 12 hollow iron columns, to support the floors and heat the rooms by steam, which the inventor also proposes to use as a means of scalding an unwelcome visitor. The outside casing is to consist of solid blocks of iron, 2ft. thick, dovetailed into each other, fused together by pouring molten iron into the joints. It is to be built on a concrete foundation, and will take 32,000 tons of iron. It will mount 70 guns, the first tier of which will be about 14ft. above high-water mark."

Peak Load Gas Turbine with Air Storage

By B. WOOD, M.A., and T. F. WICK, B.Sc.

Cheaper means of meeting the peak demand on electric power supply networks are continually being studied. Among these is the oil-fired gas turbine which, however, in orthodox form suffers from the drawback of having to drive its own compressor, absorbing two-thirds of the gross output. It has long been clear that if the turbine could be supplied with air compressed in some other way or at some other time, e.g. during the night, the effective turbine output would be trebled and the cost per kilowatt reduced to about one-third. However, the cost of metallic receivers was found to be crippling. The possibility of using underground caverns has been brought nearer to realisation by their successful use as gas holders and for storage of compressed air for operating an engine test plant in Sweden. By underground storage of air at constant pressure under a water seal the probable costs of a peak load gas turbine station seem to be brought well below those of hydraulic pumped storage. Such plant would offer additional night load which the coming nuclear stations will urgently require.

Historical Review

IN 1938, when it became clear that the industrial gas turbine was about to become available as a peak load prime mover, a study was made of the cost of storage of town's gas in steel receivers at various pressures in sufficient quantity to run a sizeable gas turbine station for a few hours. The idea was that gas turbines were to be installed near the centres of cities so as to relieve the distribution system during the load peaks. The duty contemplated was 300 hours use per annum. The notion of burning gas and not oil arose out of a misunderstanding over the name, but nevertheless the investigation was carried out seriously. The result was, however, adverse to the storage idea primarily because gas was too dear. So for a time the storage scheme died in favour of the oil-fired gas turbine which had to wait until after the war.

In about 1948 Mr. J. R. Beard suggested the possibility of utilising abandoned mines as sumps out of which water could be pumped during the night in order to generate power by letting it run back through hydraulic turbines during the day. Consideration showed, however, that to pump in air so as to displace water and to let out the air through a gas turbine (burning fuel) was actually more attractive as not only producing more power from a given cavity but also not involving plant at the foot of the shaft. The germ of the idea of air storage was thus conceived, but the project again was not actively pursued because it appeared that the cavities left by removing coal were in large part eliminated by subsidence, and that they would rarely be sufficiently airtight.

A little later Sir Edward MacColl revived the notion of the hydraulic air compressor (in which air entrained by water is compressed in an inverted syphon) and suggested its combination with a gas turbine. The scheme had considerable merit since the hydraulic compressor, according to tests in 1907 on the earliest large-scale example at Rockland, Michigan, was more efficient than any mechanical one can hope to be. Since, however, a considerable flow of water was required, together with a largish cavern well below the level of the stream, and also fuel oil would require to be delivered to the site, conditions were not found conducive to its use. The next idea was therefore to adapt it to use a relatively small stream for compressing air during the whole twenty-four hours and to let this air out of storage over a few hours to drive a gas turbine on peak load. It was fully appreciated that in either case great advantage lay in the cheapening of the gas turbine by freeing it of the duty of driving its compressor, as this resulted in roughly tripling the output of a given turbine. A description of such a scheme was published in THE ENGINEER of January 18, 1952, and this contained all essential features of a gas turbine plant with air storage under a water seal. The idea was not pursued to the point of installing a plant, however, partly because a suitable site would necessarily be remote from the load centres whereas local generation of peak load is really called for in order to relieve the transmission system. For a given outlay of capital it seemed therefore more attractive to install a hydraulic turbine at the fall, and an orthodox peak load gas turbine near the load.

Revival of the air storage idea in several countries owes its stimulus to the simultaneous development of underground gas storage in France (Beynes), Germany (Engelbostel), and the U.S.A., where it was found attractive to force gas into certain anti-clinal formations containing porous sands under an impervious stratum. While this technique is quite successful for seasonal gas storage where the extraction rates are low, it appeared unlikely to be of use for the much higher flow rates required in daily storage of air for gas turbines. At Trollhättan in Sweden by 1952 a cavern had been hewn out of rock to form a reservoir for compressed air for operating aircraft engine test rigs of Svenska Flygmotor Aktiebolaget. This plant stored air under a water seal. Later, another possibility was suggested, namely, gas storage in salt caverns. This has now been adopted commercially by the Northern Gas Board, a suitable large cavity having been dissolved away since 1957 at Port Clarence on the Tees in the process of extraction of brine for salt manufacture. In this case gas is not stored under a water seal but will be in any future job, as this results in more effective use of the storage volume and an almost constant pressure which avoids any possibility of subsidence where large caverns are involved. It demands, however, the provision or existence of an upper reservoir to catch the water displaced. Mr. R. G. Voysey, of the then Ministry of Fuel and Power, took up the idea around 1952, and looked into various alternative means of reducing the cost of the cavern, including employment of disused gypsum mines and coal mines, as well as specially-made salt caverns or excavations in rock. In the U.S.A. the creation of a cavern by a nuclear explosion has been suggested more recently. This is supposed to be so adjusted as not to break out but to melt the rocks to produce an impervious glassy lining.

Comparison With Pumped Storage

Comparison as regards cost per kilowatt and other characteristics is naturally made with hydraulic pumped storage as offering the closest analogy. A target overall capital cost may therefore be set at something of the order of £42 per kilowatt (based on Ffestiniog) which the air storage plant has to better in order to be competitive. In fact, the assignment is rather easier than that because the pumped storage plant demands a favourable terrain which is not found on many sites in England, and some of those may be expected occasion bitter opposition. Sites in Wales or Scotland are, on the other hand, not well placed in relation to the main load centres, so considerable transmission costs, say, a token £10 per kilowatt per 100 miles, might be charged against them.

It is, however, necessary to bear in mind that in the price range of £35 to £45 per kilowatt there are other rivals. Among these is the straight oil-fired gas turbine in 25MW size as supplied by Brown Boveri to (among others) the 100MW Port Mann Station in British Columbia—total cost for the finished station £46 per kilowatt. A station cost in the region of £40 per kilowatt is also probably attainable by using a modified aircraft gas turbine in the size range 3MW to 10MW. The low price in this case is a result of series production of a short-life machine on which the development charges have been allocated elsewhere. At the other end of the scale a somewhat surprising recent development is an orthodox steam power station with units of 350MW or thereabouts at a cost of £39 per kilowatt.

On the basis of the order of cost quoted for Port Mann (modified for 50 c/s), the plant and buildings of the air storage station are, on a quick assessment, assumed to work out at about £16 per kilowatt. The shaft, cavern and reservoir cost should therefore not rise above about £20 per kilowatt if the scheme is to be really competitive.

The roles and capabilities of the various types of plant mentioned above are not the same, however. Either size of gas turbine can be run up and put on full load within fifteen minutes and might be remote controlled as in Port Mann and Princetown. A somewhat shorter time could apply to the air storage gas turbine. The pumped storage plant can probably come up within three to five minutes. Each of these can start several times per day if necessary and are therefore suited to pure peak lopping duty which might be thought of as four hours per weekday for three months of the year, making, say, 240 hours' use per annum. Some quite large steam turbines can be run up in ten minutes or so from warm condition and are suitable for single or two-shift operation, as all orthodox plant is always expected to be relegated to secondary duty before the end of its financial life. Nevertheless, it is difficult to conceive of to-day's large sets being used on pure peak service, for which forty-year-old plant designed for 200 lb per square inch, 700 deg. Fah. is quite suited. For any type of plant fuel cost is of minor consequence at 240 hours' use per annum, whereas staffing requirements and maintenance become important.

In one respect the analogy between pumped storage and air storage fails. The pumped storage plant merely gets back the energy pumped up during the night, less losses—usually resulting in an efficiency of about

65 per cent. The air storage plant, on the other hand, does not rely only on the energy stored in the compressed air. Indeed, when the air is cooled back to atmospheric temperature, it contains nominally no available energy. The power generated is obtained largely from fuel burnt in the combustion chamber. This is necessary if only to prevent freezing by cooling in the turbine. Hence, unlike the pumped storage plant, the air storage one must have access for delivery of oil and be furnished with oil storage tanks. Paradoxical as it may seem, the cost of fuel is nevertheless a minor factor in costs at 240 hours' use per annum.

Elements of an Air Storage Station

The elements of the plant derive from existing gas turbine technique and are shown in Fig. 1. The only important departure

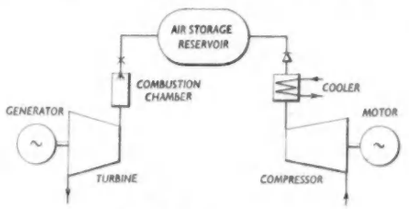


Fig. 1—Cycle diagram

from the normal gas turbine consists in removing the compressor from the turbine shaft and driving it separately by an electric motor. The power required for compression is taken from the public supply mains during the night, thus providing additional night load, which the future nuclear stations will require. As a night consumer, however, the air storage plant, because much of its output comes from fuel, is only half as effective per kilowatt generated as is pumped storage plant, requiring only 187kWh input power to produce 240kWh of output against the pumped storage input of 370kWh.

As mentioned already, the gas turbine, freed of its job of providing its own compressed air, now can generate something like three times as much power. It is also freed of limitations imposed by matching considerations with the compressor. The compressor, if required to produce in a twelve-hour night the air consumed by the gas turbine in a four-hour day, need only be of one-third the normal size. It will be understood that, according to the air pressure in the circuit, which is set by the height of the water column, the compressor and turbine may require one, two, or more cylinders and, whereas in the gas turbine proper some of these may be on free shafts, it now becomes necessary to couple all turbines to the alternator and all compressors to the motor. There are thus limitations imposed by the available size of gears and suitable motors. These can only be studied by taking a practical example.

The most appropriate machine, as being a well-known and adequately tried set of high pressure ratio, is the Brown Boveri nominal 25MW unit mentioned above. Some twenty-three have been ordered, of which about thirteen are in service. It consists of two lines. The low-pressure line runs at 3000 r.p.m. and consists of the l.p. turbine, l.p. compressor and generator. The high-pressure line is a free shaft comprising h.p. turbine and h.p. compressor running at about 4600 r.p.m. Each turbine is preceded by a combustion chamber. There is no regenerator. Intercooling takes place between the low-pressure and high-pressure compressors. The air mass flow is around 360 lb per second and the pressure ratio is about 16 : 1. The efficiency is about 25 per cent at 60 deg. Fah. water and air suction temperatures and at 1200 deg. Fah. (650 deg. Cent.) turbine inlet temperature.

For the air storage application it is necessary to modify the h.p. turbine so as to run direct coupled at 3000 r.p.m. or to couple through gears if 4600 r.p.m. is retained. The alternator has to be increased to a size appropriate to the gross output of the two turbines viz. about 80MW. The compressors, as already mentioned, can be reduced to one-third size to provide a mass flow of, say, 120 lb per second (requiring a total of, say, 20MW, instead of about 55MW). Their speeds for this duty are likely to be above 3000 r.p.m., but can be chosen quite freely since a four-pole motor is preferred as having good starting characteristics and so step-up gears will in any case be necessary. Requirements are then well within standard design limits. The high-pressure compressor is followed by an after-cooler, since it is necessary to remove most of the compression heat to prevent boiling the water in the cavern or causing a geyser when the water loses pressure in coming up the shaft. The coolers are also of course of one-third normal size.

The pressure of 16 atmospheres fixes the required depth of cavern at about 500ft. The pressure ratios of the two turbines and two compressors can be settled independently of work balance considerations. The cavern capacity required for four hours generating duty is about 5,000,000 cubic feet. A reservoir of the same capacity is required on the surface to contain the water displaced. At 20ft deep this implies about 6 acres. The shaft might be of about 7ft diameter with a 2ft diameter pipe running inside it. A schematic arrangement of the resulting plant is shown in Fig. 2.

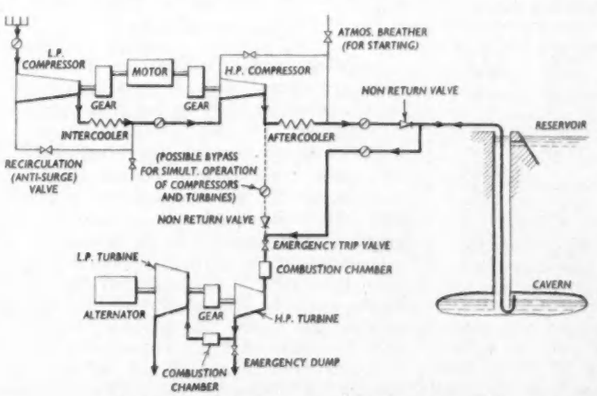


Fig. 2—Schematic arrangement of air storage plant

Choice of Air Storage Pressure

In principle one is free to adopt any depth of cavern below the land surface, but because current gas turbine practice uses maximum cycle pressures in the region of 16 to 20 atmospheres, a depth of around 500ft–650ft is to be preferred, at least for an initial installation. Nevertheless, greater depths are not out of the question, and have the advantage that the potential energy output per unit cavern volume is increased not only by the higher expansion ratio but also by the greater mass of air stored. The following table illustrates this point.

Effect of Depth of Cavern on Potential Energy per unit Volume of Storage

Depth (feet)	Storage pressure (atm.)	Pound of air stored per cubic foot of cavern, c.f. 16 atm. case	Assumed No. of expansion stages (each at 4/1 ratio)	Work per pound of air relative to 16 atm. case	Energy per cubic foot of storage relative to 16 atm. case
103	4	¼	1	½	⅛
513	16	1	2	1	1
2170	64	4	3	1½	6

The main attraction of high pressure accordingly lies in greatly diminishing the proportional cost of the cavern. Thus at low depths a natural cavern is almost essential for economy but at great depth an artificially excavated one becomes economic.

Although a pressure of 64 atmospheres is outside present gas turbine practice it is quite possible of achievement and could be obtained by adding another stage of compression and another of expansion to the arrangement suggested above for 16 atmospheres. Ideally the kilowatt rating of the set should be increased in proportion, i.e. by 50 per cent, so as to preserve the same volume flows in the intermediate and low-pressure cylinders and thus avoid any reduction in cycle efficiency arising from a change to smaller capacity machines. Because of its low volumetric flow the third (high-pressure) compressor might well be of the centrifugal type.

Dry Storage Alternative

An alternative to storage under a water seal is dry storage by simply pumping up the pressure in the receiver. There are two main objections to this. First, the variable pressure is a disadvantage : it means that the turbine output falls during the discharge cycle and also means that the compressors do not work at their best efficiency at reduced pressure unless run at variable speed.

Secondly, the weight of air obtainable from a given storage volume is distinctly less with dry storage. This means that if, for example, the variation in working pressure is limited (from machine performance considerations) to 10 per cent, then, for the same size of cavern, the alternative water displacement method would give about fourteen times as much power. For 20 per cent pressure range the factor is about 7.

Form of Cavern

According to the locality the cavern might be formed by dissolving salt or by hewing out gypsum or other rock, a wide range of strata being suitable. There are also possibilities of using existing caverns, particularly natural ones in limestone, or abandoned lead, iron or gypsum mines. Limestone occurs in a belt running diagonally across England from the Dorset coast to the north-east coast, and mountain limestone occurs in various parts of the Pennines. Many

caverns are known, but there are probably many others as yet undiscovered because apparatus to detect them has not been deployed. (The underground test explosions at present being prepared by the Atomic Energy Authority may offer an opportunity to make seismic surveys.) However, natural caverns will not all be at suitable depth and their sealing-up might well entail rather expensive works. Coal mines are not regarded as likely to be usable. Salt is found at suitable depth—down to 1200ft—in several regions in Cheshire, Staffordshire, Lancashire and the North-East. Gypsum or anhydrite occurs in Cumberland and the North-East and East Midlands, but the largest mine is near Robertsbridge in Sussex.

The cost of forming the salt cavern at Port Clarence for gas storage appears to have been in the region of £0·1 per cubic foot though a lower price might result if the scale were larger. Port Clarence is 338,000 cubic feet at about 1200ft deep, 450 lb per square inch. A much lower price, of the order of £0·015 per cubic foot, has been quoted for an excavation in gypsum after allowing for the value of the product. Based on the Trollhätten cavern (388,000 cubic feet, depth 280ft) rock excavation might be expected to cost something of the order of £0·25 per cubic foot (with shaft). Very much lower estimates are sometimes made but it seems better to use only factual figures. Estimates of cost of shaft sinking also vary very widely. For a 7ft diameter shaft we assume a price of £40 per linear foot for 500ft deep. In hilly terrain an alternative construction consists of forming a cavern at valley level by entering the hillside horizontally. A reservoir at a suitable height above is then required. The water pipe could be run on the slope of the hill, as in hydraulic plants. An air pipe communicating between the top of the cavern and the plant is also required, the entrance to the cavern being sealed.

Estimated Cost of Station

The following table is for 80MW net output, 20MW input, and refers to use of a salt cavern.

Estimated Cost of Station with Salt Cavern

	Estimated capital cost, £	Cost per kW on 80MW, £
(1) Turbines and compressors, with motor and generator, also valves, ducting and miscellaneous equipment	880,000	11·00
(2) Fuel tanks, pumps and pipework ; cooling tower, pumps and C.W. pipework	55,000	0·69
(3) Switchgear, transformers, cabling	150,000	1·87
(4) Buildings and foundations, crane, site clearance and roads	140,000	1·75
(5) Cavern (salt)	660,000	8·25
(6) Shaft	22,000	0·27
(7) Reservoir	56,000	0·70
	£1,963,000	£24·53

Alternatively, for a rock cavern item 5 is increased from £8·25 to £20·6 per kilowatt and the total station cost becomes £36·88 per kilowatt.

The largest item in the estimate is the price of the plant quoted by the maker, which since the plant is assumed to be imported includes the necessary duty. The next largest is the cavern cost which is naturally a variable depending on the site. The estimated total cost of the power station plus storage is of the order of £25 per kilowatt for the rock salt case. There would appear to be sufficient margin between this figure and those quoted for hydraulic pumped storage (e.g. £42 excluding transmission) to make a prima facie case. It will be clear that the cavern cost (though factual) could be lower in some cases and higher in others. At the cost of excavation in rock based on the Swedish plant a cavern cost of about £20 per kilowatt does not seem to price the plant out of the running. Moreover, some saving might be expected through the larger size involved.

It is to be noted that if a salt cavern were used the brine would be saturated. Hence its density would be about 1·22. Thus the depth of shaft required is reduced. On the other hand, the air pipe must be protected against corrosion by strong brine. No attempt has been made to allow for this. In addition the cooling water circuit would need to be separate from the reservoir, whereas with fresh water the reservoir can serve as a cooling pond, with the high temperature part of the cooling process being done by sprays. On a favourable site with deep cavern the reservoir might be unnecessary, because either an existing lake or river might be used, or even the sea. Otherwise the rock excavated (unless valuable) would, it is assumed, be used to form the embankment of an artificial reservoir.

Estimated Cost per Unit Generated

The typical duty in peak lopping service has been discussed as 240 hours' use per annum. However, if the purpose of the station were primarily to provide additional night load for nuclear stations the plant might be used each day throughout the year, involving, say, 1500 hours of generation. Both cases are considered below.

Estimated Cost per Unit Generated with Annual Utilisation of (1) 240 *Hours*, (2) 1500 *Hours*

Case	No. 1	No. 2
Annual kWh generated per kW installed	240	1,500
Annual kWh consumed per kW installed	187	1,170
Tons of fuel oil used per annum ...	2,660	16,600
Cost of fuel oil per annum	£26,600	£166,000
Costs in pence per kWh generated		
Electrical energy	0·39	0·20
Fuel oil at £10 per ton	0·33	0·33
Annual charges (8 per cent on £24·5/kW)	1·96	0·31
Operating costs	0·10	0·08
Total annual cost in d/kWh generated	2·78	0·92

Night energy for compressing (Case 1) is taken at fuel cost of 0·5d. per kilowatt hour based on coal at £4·8 per ton and a generation efficiency of 30 per cent. A lower incremental night energy cost, about 0·25d., will result from nuclear stations (Case 2), even though the average cost per kilowatt-hour might be 0·8d. It is assumed no kilowatt charge is made for night energy.

Considering the above costs per kilowatt-hour generated, it is clear that for short period duty the largest item is the cost of capital, and hence the general philosophy must be based on a low capital cost design and maximum output of the turbine. As regards the rating of the turbine in cold weather, it is to be noted that unlike the self-contained gas turbine the machine under discussion shows substantially no output response to varying air temperature. The compressor power will, of course, vary with the density of the air at its intake and the compression work per pound will also vary with the intake and recooled temperature.

A token oil price of £10 per ton is taken. Residual oil might be cheaper but would entail heating. There is, of course, any amount of waste heat at suitable temperature in the cooling water and in the outlet gases, but the benefit of this is felt only when the plant has done some running. Hence light oil would be necessary for starting up. Residual oil would also have to comply with certain requirements as to solubility of ash, and must be assumed to involve periodic turbine washing. A blend of heavy and light oil might be found the best compromise bearing in mind the small influence of oil price on the operating cost, at least in Case 1.

Operating wages depend on the staffing arrangements, which are somewhat unusual. For weekday generation in the winter months only, three shifts on five days appear sufficient, and the staff are required for only a part of the year. Their services in the summer should preferably be charged to some other station where they might act as reliefs. Repairs and maintenance can only be settled by experience, since published data on sufficient long-term experience relates only to Beznau Station, Switzerland, with another type of unit.

Efficiency

The thermal efficiency of the basic unit as a self-contained gas turbine is about 25 per cent. However, in the air storage application there are additional losses due to the removal of compression heat in the after cooler and extra parasitic pressure drops. On the other hand, component efficiencies can be higher than normal since the compressor works at a substantially constant pressure and the turbine at a fixed mass flow. The gross thermal efficiency of the turbine reckoned as thermal equivalent of energy output divided by heat in the fuel is about 60 per cent. The energy input to the compressor and to the cooling water pump, &c., can be thought of as auxiliary consumption albeit not coincident. This means that the output falls from 240kWh per annum gross to a net 240—187=53kWh so the net efficiency is only 13 per cent. This calculation is, however, particularly sensitive to the assumptions made regarding losses in transformers and auxiliaries as well as in pressure drop, and these have been taken conservatively. Moreover such an "efficiency" is not necessarily relevant because, as mentioned, the 187kWh may be produced by cheaper fuel, and in any case the "dollar efficiency" is what counts. The equipment indeed seems capable of producing kilowatts to order, subject to certain restrictions, at a lower price than any other, with the exception of time-expired steam plant standing at zero capital cost.

The thermal efficiency could be improved by use of a regenerator, but this is not recommended for peak load duty since its capital cost could not be justified. Moreover with cold air from the cavern there is serious risk of corrosion from sulphur on the gas side.

Control of Load

It is assumed that the plant would be utilised to full extent when on load, and hence part load operation is not an important requirement. Control of the turbine when running up and building up load would be by a combination of throttling and regulation of fuel to give the desired inlet temperature. The turbine is self-starting. When the stored air is used up the plant is, of course, useless—in a single unit station it cannot run itself even if the compressor is motored. However, if it were desired to extend the running time at the expense of reduced output the compressor could be run while the plant is generating. Another way of extending the running time and obtaining extra kilowatt-hours (though not extra

kilowatts) at the expense of additional fuel is to inject water into the combustion chamber.

Starting of the compressor motor would be by the modified Korndorfer method already used with success elsewhere. The short-rated starting transformer would be in series with the main transformer which serves for both generator step-up and the motor.

Conclusions

The main advantages of the air storage plant appear to be as follows :

(1) The estimated capital cost per kilowatt in favourable circumstances using natural or specially made caverns is distinctly lower than that of larger hydraulic pumped storage plants.

(2) It can use a wide variety of types of terrain. Hence in England such plant could be more easily sited near the centres of load, thus avoiding the high transmission costs associated with most pumped storage sites.

(3) The size of unit—about 80MW—can readily be accommodated on any part of the grid system without serious additional transmission costs.

(4) For a given storage volume or water quantity it can give four to nine times as much energy output as with the hydraulic method (according to depth).

(5) The low cost per kilowatt would be even more marked if several units were installed in the same station so as to reach an output comparable with that assumed for hydraulic pumped storage plants.

The Fairlie Locomotive

ITS USE THROUGHOUT THE WORLD

By R. A. S. ABBOTT, Member, Newcomen Society

No. III—(*Continued from page* 385, *March* 4)

The history of the Fairlie locomotive, although of great technical interest, is a subject that has never received due attention from engineering historians, and the literature relating to this particular phase of locomotive development is extremely limited and is mainly confined to isolated references in early periodicals. When the history of the seventeen Fairlie locomotives that have operated on railways in Great Britain and Ireland was published in "The Engineer" of December 5, 1958, the author expressed the hope that at some future date he would be able to deal with the use of this type of locomotive in other parts of the world. Now, as much hitherto unpublished information has recently been released from official sources both in Great Britain and overseas, it has become possible to present for the first time a more comprehensive survey of the world use of the Fairlie locomotive.

IN 1874 a 0–4–4–0 locomotive (Fig. 19), named "Robert Fairlie" (Works No. 734) was completed to the order of the Fairlie Engine and Rolling Stock Company for the Norwegian State Railways. No dimensions are available except that the cylinders are thought to have been 11in in diameter by 18in stroke, and the wheels 3ft 3in in diameter.

Two 0–4–4–0 locomotives (Fig. 20) were exported during 1875 to Portugal for service on the Porto a Pavoa de Varzim Railway. Built to the order of the Fairlie Engine and Rolling Stock Company, these engines (Works Nos. 740 and 741) were named "Rio Douro" and "Rio Aye," and had cylinders 10in in diameter by 18in stroke and wheels 3ft 3in diameter, but their subsequent history is not known,

After completing the "Taliesin" for the Festiniog Railway in 1876, no further Fairlie type locomotives were built by the Vulcan Foundry during the next twenty-five years until in 1901 the firm introduced a modified form with two separate boilers carried on a single deep girder frame. One advantage of this type is that the variation of the water level on grades is reduced, although the overall length of the locomotive is increased by an amount equal to the distance between the two fireboxes. Seven of these locomotives (Fig. 21) were constructed for the metre gauge lines of the Burma Railways, of which five (Works Nos. 1773–1777) were completed in 1901 and two (Works Nos. 2200–1) during 1906.

The principal dimensions were : cylinders 14in in diameter by 20in stroke ; wheels 3ft 3in in diameter ; bogie wheelbase 7ft 7in ; total wheelbase 35ft 7½in. Each boiler barrel had a length of 8ft 5in and was 3ft 6½in in diameter, containing 152 tubes of 1⅝in diameter. The combined heating surface was 1132 square feet in the tubes, 138 square feet in the fireboxes, and 128 square feet in the Drummond water-tubes fitted in each firebox, giving a total of 1398 square feet—grate area 13 square feet in each firebox. The water capacity was only 500 gallons while the bunkers held 2½ tons of coal. The weight in working order was 60½ tons. These locomotives were fitted with a modified form of Joy radial valve gear in which the anchor link was attached to a small return crank in line with the main crank. A similar arrangement had previously been used on a small industrial locomotive built by A. Barclay, Sons and Co., of Kilmarnock, in 1897.

During 1911 the Mexican Railway received three 0–6–6–0 locomotives (Works Nos. 2586–2588) designed to haul 300-ton trains up the 1 in 25 grades of that system. At that date, these large and imposing machines (Fig. 22) were probably the heaviest built in Britain for the standard gauge, the total weight being 138 tons or 23 tons per axle. The cylinders had a diameter of 19in and the stroke was of the unusual length of 25in ; wheels 4ft in diameter ; bogie wheelbase 9ft 3in ; total wheelbase 35ft 6in. The tube heating surface amounted to 2679 square feet, and that of the two fireboxes to 245 square feet, bringing the total heating surface to the high figure of 2924 square feet. The fireboxes had rocking grates and were designed for either coal or oil firing ; the combined grate area was 47·7 square feet. A single steam dome was provided on the back ring of one boiler and this was equipped with four 3½in Ashton pop safety valves set to a working pressure of 185 lb per square inch.

These were the last locomotives of the type ordered by the Mexican Railway, and it is of considerable interest, therefore, to note that in December, 1923, just prior to the electrification of the Orizaba–Esperanza section, there were eighteen Fairlie locomotives still in service of four different classes ; all had been converted to oil firing.

The Yorkshire Engine Company, Ltd., Meadow Hall Works, Sheffield

The records of the Yorkshire Engine Company were very inaccurately kept prior to the year 1909, when a complete list of all locomotives built was drawn up. By that time, however, much data had been lost, but it has now been established that during the early 1870s Fairlie locomotives were built to stock orders for a selling agency—gauge modifications and wheel arrangements being altered according to demand—this being the reason for the incomplete records of this type.

Ten 0–6–6–0 locomotives were built for the Mexican Railway in 1872 (Works Nos. 170–174 and 190–194). These had cylinders 15in in diameter by 22in stroke ; wheels 3ft 6in in diameter ; bogie wheelbase 8ft ; total wheelbase 29ft 5½in. The total heating surface was 1688 square feet of which the fireboxes contributed 141 square feet. The grate area was 26·6 square feet. The side tanks held 2200 gallons, but the capacity of the bunkers was only 30 cwt of coal or 180 cubic feet of wood. The fireboxes were

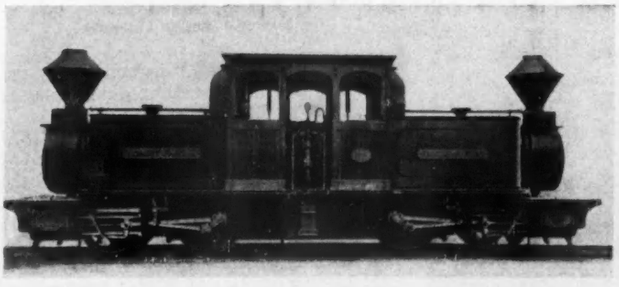


Fig. 19—Locomotive "Robert Fairlie," built to the order of the Fairlie Engine and Rolling Stock Company by the Vulcan Foundry, Ltd., in 1874 for the Norwegian State Railways

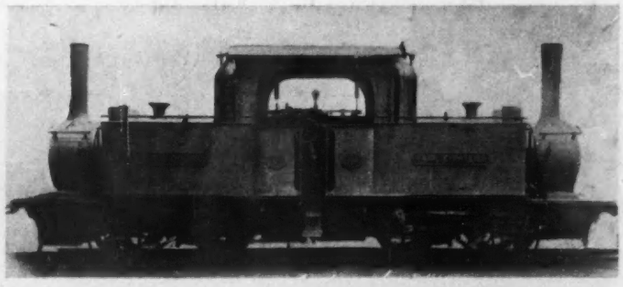


Fig. 20—Locomotive "Rio Douro," built by the Vulcan Foundry, Ltd., in 1875 for the Porto a Pavoa de Varzim Railway, Portugal, to the order of the Fairlie Engine and Rolling Stock Company

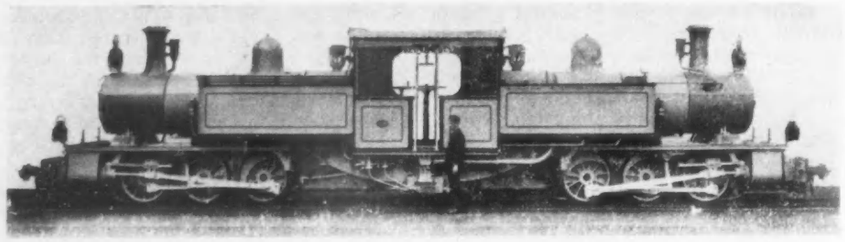


Fig. 21—Modified Fairlie locomotive with separate boilers, and external Joy valve gear. Built in 1906 by the Vulcan Foundry Company

designed to burn either coal or wood, coal being obtained at one end of the line and wood at the other. One of these engines ran trials on the Grange Colliery branch of the Manchester, Sheffield and Lincolnshire Railway in February, 1872, in the presence of forty engineers, including Robert Fairlie. Also present were the Duke of Sutherland ; His Excellency Nicholas Novosselsky, the Mayor of Odessa ; M. Landeburg, C.E. of Sweden, and M. Illimoff of St. Petersburg.

One 0–4–4–0 locomotive was sent to Rio de Janeiro in 1872 for service on the Canto-Gallo Railway, a line with the unusual gauge of 3ft 7½in. This engine (Fig. 23) has cylinders 12½in in diameter by 20in stroke ; wheels 3ft 9in in diameter ; bogie wheelbase 6ft ; total wheelbase 24ft 3½in. The total heating surface amounted to 1099 square feet, and the grate area to 17 square feet. Water capacity was 1000 gallons, and the bunkers held 30 cwt.

The locomotive illustrated in Fig. 24 was built in 1872 (Works No. 212) for the Grande Compagnie du Luxembourg, and was the only example of the type in Belgium. It carried the name " Fenton," after a Mr. W. Fenton of Rochdale, who was president of the board of directors of the old Luxembourg Railway Company, and was numbered 108 in their stock. The dimensions were as follows : cylinders 15in in diameter by 22in stroke, wheels 3ft 6in diameter, total heating surface 1580 square feet, working pressure 130 lb per square inch, weight 63·7 tons. When the railway was taken over by the Belgian State in 1873 it became No. 969 and was used principally at Brussels, hauling local goods trains between the depots at the Allee-Verte and the Quartier Leopold. Finally it was sent to the yard at Arlon, and was scrapped in 1887.

The Hallsberg-Motala-Mjolby Railway, Sweden, received two locomotives of the 0–4–4–0 type in 1874 (Works Nos. 176 and 177). These engines (Fig. 25) were at first numbered 5 and 6, but when this private line was taken over by the State in 1879, they became Nos. 285 and 286, and received the names " Berserk " and " Nidhögg." The cylinders, which had a diameter of 13in and a stroke of 20in, were slightly inclined, and had inside valves actuated by Stephenson gear. The wheels had a diameter of 3ft 10in, and the bogie wheelbase was 8ft, while the total wheelbase was 25ft 6in. The boilers had a tube heating surface of 1250 square feet, which together with 117 square feet in the two fireboxes gave a total of 1369 square feet. The grate area was 20·5 square feet, and working pressure 120 lb per square inch. These engines were originally intended to burn peat, and the bunkers had a capacity of 80 cubic feet ; the water tanks held 1450 gallons. The total weight was 48 tons 2 cwt. They were used mainly for goods traffic, but were not very successful machines. In 1887 the two locomotives were rebuilt by Nydqvist and Holm of Trollhaten into four small 0–4–2 side-tank engines, and these were finally withdrawn between 1899 and 1907.

In 1875 one 0–6–6–0 locomotive was built for South Africa, for service on the 3ft 6in gauge lines of the Cape Government Railways. This engine (Fig. 26) when sent out from England was accompanied by a special engine driver, a Mr. Edmund Roberts, who had had considerable experience with Fairlie locomotives in Peru. The cylinders had a diameter of 11½in by 18in stroke, with Walschaerts valve gear, and this was the first recorded use of this type of gear in South Africa. The wheels had a diameter of 3ft 3in on a bogie wheelbase of 7ft 6in, the total wheelbase being 29ft. The heating surface of the tubes was 908 square feet and that of the firebox 90 square feet, making a total of 998 square feet. The firegrate area was 14 square feet and the boiler pressure 135 lb per square inch. The side tanks held 840 gallons and the bunkers 42 cwt, and the total weight in working order was 36 tons. Colonial coal from Indwe and Molteno was used and this led to difficulties due to the high ash content and heavy clinker. This locomotive was scrapped in 1903.

Mr. John D. Tilney, Locomotive Superintendent, in his report of 1877 stated that for any future order of Fairlie type engines certain modifications were necessary, and suggested (1) that the Roscoe lubricator be fitted to the ball and socket joints ; (2) that the sandboxes, which were fitted to the bogie frames, were ineffective, having too much complicated gearing — sandboxes fitted on top of the smokeboxes would utilise a simpler form of gearing ; and (3) that safety chains should be fitted, or some such means of preventing the bogies from swinging round too far should the engine leave the rails. When the second Fairlie locomotive, for the Eastern section of the Cape Government Railways, was built in 1878 by the Avonside Engine Company all the above modifications were incorporated.

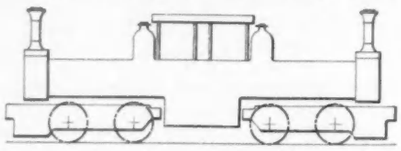


Fig. 23—Diagram of locomotive for the Canto-Gallo Railway, Brazil, built in 1872 by the Yorkshire Engine Company

In 1874 one locomotive of the 0–6–6–0 type was supplied to the Nitrate Railways, Chile. This was numbered 23 by the company and had cylinders 15in in diameter by 20in stroke ; wheels 4ft 7in in diameter ; total heating surface 1468 square feet, grate area 22 square feet. When additional motive power for this railway was required in 1880, the Yorkshire Engine Company obtained a contract for a further series of five 0–6–6–0 locomotives which became Nos. 33–37 in the stock of the Nitrate Railways. These had cylinders 17in in diameter by 22in stroke ; wheels 3ft 10½in in diameter ; bogie wheelbase 8ft 6in ; total wheelbase 31ft 11in. Heating surface : tubes 1740 square feet, fireboxes 199 square feet, total 1939 square feet. Grate area 32 square feet. Working pressure 150 lb per square inch. Two more 0–6–6–0 locomotives were supplied to this railway in 1889 (Works Nos. 446 and 447) and a final one as late as 1906. These were numbered 63, 64 and 73 respectively by the company, and had the same dimensions as those built in 1880.

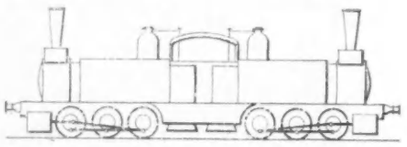


Fig. 24—Locomotive " Fenton " built in 1872 by the Yorkshire Engine Company for the Grande Compagnie du Luxembourg

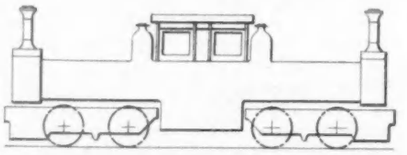


Fig. 25—Diagram of locomotive for the Hallsberg-Motala-Mjolby Railway, Sweden, built in 1874 by the Yorkshire Engine Company

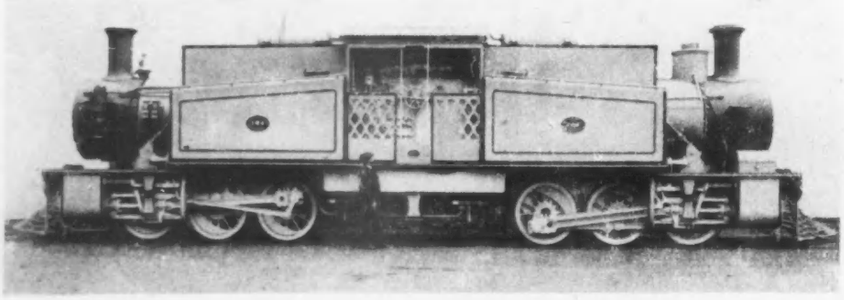


Fig. 22—The final design of Fairlie locomotive for the Mexican Railway, built by the Vulcan Foundry, Ltd., in 1911

Two 0–6–6–0 locomotives built in 1874 and two 2–6–6–2 built in 1882 were disposed of to the Russian Government for use on the Transcaucasian railway system. The first of these (Fig. 27), carried Works Nos. 225 and 226, and had cylinders 17in diameter by 22in stroke, wheels 3ft 9in in diameter, a total heating surface of 2075·5 square feet, a grate area of 33·5 square feet, and a working pressure of 160 lb per square inch. The water tanks held 2660 gallons and the

bunkers 2½ tons. The weight in working order was 77 tons.

The second pair (Works Nos. 227 and 228) (Fig. 28) were generally similar, but had a grate area of 35·5 square feet, a total wheelbase of 44ft 9in and a weight of 85 tons. The photograph reproduced here will be

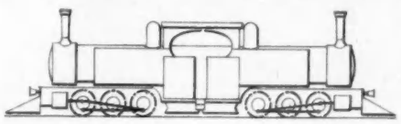


Fig. 26—Diagram of locomotive built in 1875 by the Yorkshire Engine Company for the Cape Government Railways

found in two previous publications, first in *The Locomotive Magazine Souvenir*, No. 27, which appeared during 1917, and again in *Articulated Locomotives* by L. Weiner, 1930, page 142, and on each occasion this locomotive is described as having been supplied to the Nitrate Railways, Chile. However, according to a very full and authoritative article dealing with the locomotive history of the Nitrate Railways published in *The Locomotive* for 1932, it appears certain that no 2–6–6–2 locomotives were used on this line.

During 1883 three 0–6–6–0 locomotives were built for the Mexican Railway (Works Nos. 365–367) and these had cylinders 16in in diameter by 20in stroke, with Allan straight link valve gear ; wheels 3ft 9in in

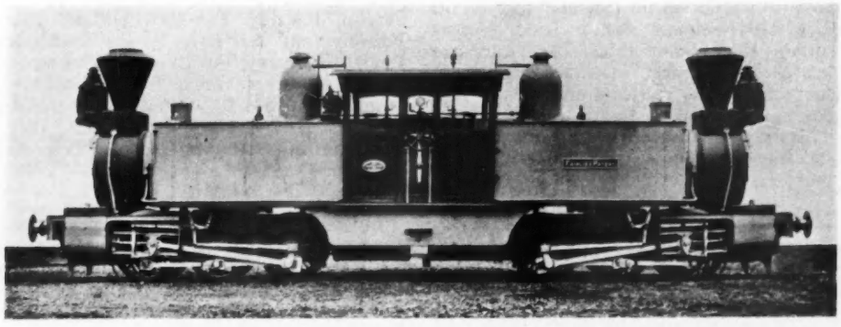


Fig. 27—Locomotive built in 1874 by the Yorkshire Engine Company and acquired by the Russian Government for use on the Transcaucasian railway system

diameter ; bogie wheelbase 8ft 3in ; total wheelbase 30ft 3⅛in. Total heating surface 1660 square feet. Water capacity 2350 gallons. The coal bunkers held 1 ton 10 cwt. The photograph (Fig. 29) which illustrates these engines, also serves to illustrate the series built by Neilson and Co. during the same year for this railway. The two series were identical in outward appearance, although the Neilson ones had larger cylinders and boilers, together with a larger coal and water capacity.

The Anglo-Chilian Nitrate and Railway Company operate about 184 miles of 3ft 6in gauge track connecting the two large natural nitrate plants, Maria Elena and Pedro de Valdivia, with the port of Tocopilla, and reaching an altitude of about 4500ft, but in contrast to the Nitrate Railways only two Fairlie type locomotives were used. These locomotives, built in 1891 (Works Nos. 446 and 447) are illustrated in Fig. 30 and had cylinders 14in in diameter by 20in stroke ; wheels 3ft in diameter on a bogie wheelbase of 6ft 10in ; total wheelbase 25ft 10in. Total heating surface 1224·4 square feet. Grate area 19·3 square feet. With 1100 gallons of water and 1 ton 6 cwt of coal the weight was 52 tons 4 cwt. Numbered 8 and 9 by the company, these engines were withdrawn about 1929.

The Junin Railway is a 2ft 6in gauge line which, like all the railways serving the nitrate area of Chile, ascends the coastal plateau. The ascent from sea level is so steep that the railway begins at the top of the escarpment at an altitude of 2080ft, and is connected with the port of Junin by an aerial ropeway. From the coastal terminus at Alto de Junin to Reducto the line climbs 1680ft in 31·8 miles by gradients of 1 in 35 and curves of 328ft radius, and to operate heavy trains over this section the company ordered two 0–6–6–0 Fairlie locomotives, of the modified type with two separate boilers, in 1905 (Works Nos. 834 and 835). Named " San Antonio " and " Compania " respectively, these engines had the following principal dimensions : cylinders 12½in in diameter by 16in stroke ; wheels 2ft 6in in diameter placed inside the frames ; bogie wheelbase 6ft ; distance between bogie pivots 21ft 10½in ; total wheelbase 29ft 4½in. The boilers had a tube heating surface of 930 square feet, and the fireboxes, of the Belpaire type provided a further 117 square feet making a total of 1047 square feet. Grate area 21·66 square feet. Weight, with 1500 gallons and 2 tons of coal, 52 tons 2 cwt.

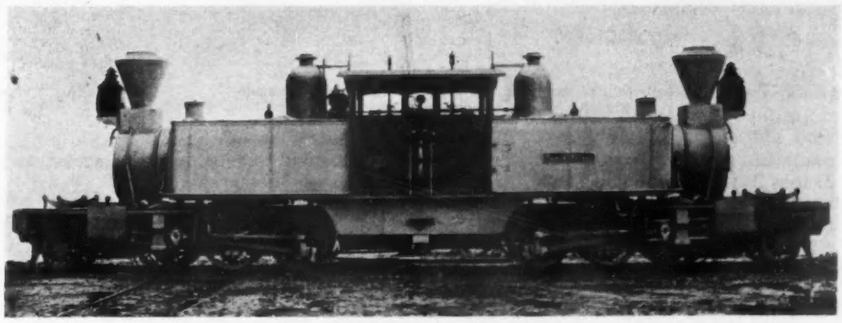


Fig. 28—Locomotive built by the Yorkshire Engine Company in 1882 and acquired by the Russian Government for use on the Transcaucasian railway system

The difficulty arising in connection with the reversing of the Walschaerts valve gear, due to one end of the swing-link being attached to the carrier frame and the other to a moving bogie, was obviated by locating the reversing shafts at the top of the tanks. A very long swing-link was thus obtained and there was practically no slip in the die due to the movement of the bogie when rounding curves. A photograph of these locomotives appeared in *Articulated Locomotives* by L. Weiner, 1930, page 153.

R. and W. Hawthorn and Co., Forth Banks Works, Newcastle on Tyne

This Newcastle firm constructed four Fairlie locomotives of the 0–4–4–0 design during 1874 for the Nassjö-Oscarshamn Railway, Sweden. These engines (Fig. 31) carried Works Nos. 1636–1639, and were named " Berga," " Målilla," " Mörlunda " and " Marianneland," the railway numbers being 6 to 9. The cylinder diameter was 10in and the stroke 18in ; wheels 3ft 6in in diameter ; bogie wheelbase 5ft ; total wheelbase 19ft 7in ; overall length 29ft 6in. The boiler barrels had a length of 8ft 6in and a diameter of 2ft 9¼in, the combined tube heating surface amounting to 743 square feet which, together with 68 square feet in the two fireboxes, made a total of 811 square feet of heating surface. The grate area was 10 square feet. With 850 gallons of water and 14 cwt of

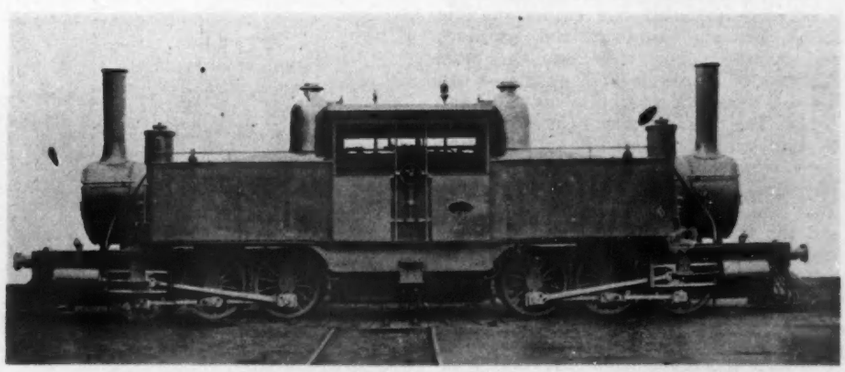


Fig. 29—Locomotive built in 1883 for the Mexican Railway by the Yorkshire Engine Company

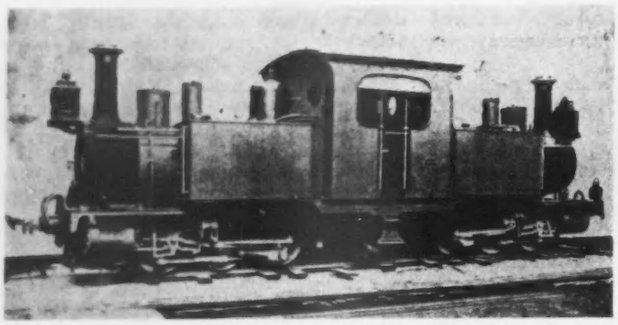


Fig. 30—Locomotive built for the Anglo-Chilian Nitrate and Railway Company by the Yorkshire Engine Company in 1891

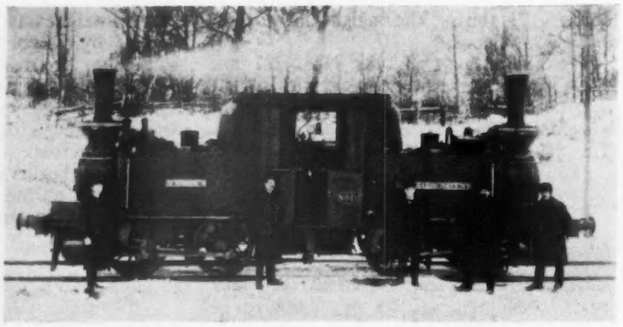


Fig. 31—The "Malilla" built by R. and W. Hawthorn and Co. in 1874 for the Nassjö-Oscarshamn Railway, Sweden

coal the weight in working order was 27 tons 2 cwt. Nos. 6 and 7 were broken up in 1910, and Nos. 8 and 9 sold to a railway contractor in 1899.

In 1876 two 0–6–6–0 locomotives (Works Nos. 1689 and 1690) were delivered to the Bolivar Railway, a 2ft gauge line in Venezuela connecting Barquisimeto with Tucacas on the Caribbean. These had cylinders 9in in diameter by 14in stroke, wheels 2ft 6in in diameter and an overall length of 33ft 3in. Some years later, in 1890, a similar locomotive was supplied to the 2ft gauge industrial railway of the Quebrada Copper Company in Venezuela. This engine had cylinders 9in in diameter by 14in stroke; wheels 2ft 6in in diameter; bogie wheelbase 6ft; total wheelbase 22ft 8in; overall length 32ft 2in. The weight was 23 tons. It was later acquired by the Bolivar Railway. The Norwegian State Railways received one 0–4–4–0 locomotive in 1877 (Works No. 1697) and this was named "Robert Fairlie"; built to a gauge of 3ft 6in it had cylinders 10in in diameter by 18in stroke and wheels 3ft 3in in diameter. The overall length was 31ft.

The next locomotive, Works No. 1699, of 1877 was of the 0–4–4 single-boiler type, with only one power-bogie, and built to the order of the Fairlie Engine and Rolling Stock Company presents a mystery that has hitherto escaped notice by locomotive historians. It was constructed to exactly the same drawings as the single-boiler Fairlie used on the Swindon, Marlborough and Andover Railway, and which is said to have been built by the Avonside Engine Company in 1878 to the order of the Fairlie Engine and Rolling Stock Company. There are no official records as to what became of this Hawthorn locomotive, and it may well be that it was the one that appeared on the Swindon, Marlborough and Andover Railway in 1881 and that the Avonside Engine Company had nothing to do with the matter.

For working on 2ft 5½in gauge lines, having 3 per cent gradients and curves of 50m radius, between Hainsberg and Kipsdorf, and Alterburg and Heidenau, the State Railways of Saxony in 1885 purchased two 0–4–4–0 locomotives (Works Nos. 2012 and 2013). The cylinders were 8¼in in diameter by 14in stroke; wheels 2ft 8in diameter; bogie wheelbase 4ft 6in; total wheelbase 18ft 8in; overall length 27ft 10in. The total heating surface was 692·6 square feet and the grate area 13·5 square feet. The weight empty was 22 tons. These locomotives, which were considered to be rather expensive, were satisfactory for a time but they were ultimately replaced by the Meyer type.

Messrs. Robert Stephenson and Hawthorns' records of this period were all destroyed by fire some years ago, and it has therefore not been possible to illustrate this section with any official photographs.

Neilson and Co., Hyde Park Works, Glasgow

Between 1883 and 1901 this famous Scotch firm supplied fifteen Fairlie locomotives to the Mexican Railway. In 1883 three of the 0–6–6–0 type were built (Works Nos. 2874–2876) and these carried railway Nos. 156–158. They had exactly the same external appearance as the three supplied to this railway by the Yorkshire Engine Company in 1883 (see Fig. 29). The cylinders were 16in in diameter by 22in stroke, with Allan straight link valve gear; wheels 3ft 9in in diameter; bogie wheelbase 8ft 3in; centres of bogie pivots 22ft; total wheelbase 30ft 3in. The heating surface of the fireboxes was 166 square feet and that of the tubes 1647 square feet. Total heating surface 1813 square feet. The grate area was 29·4 square feet. The two bogies were connected by a carrier frame which supported the boiler, footplate, tanks and bunkers, and took all buffing and traction stresses. Each bogie pivot consisted of a short gun-metal cylinder, 20in in diameter, fixed to a cross member on the carrier frame and fitting into a shallow cast iron socket fastened to the bogie. These were large locomotives and their weight in working order with 2850 gallons of water and 3¾ tons of coal was 92¼ tons. A contemporary report claimed that these engines were capable of hauling a train weight of 3600 tons on the level.

During 1889 the first of a new class of twelve 0–6–6–0 locomotives appeared, and these were delivered over a period of twelve years in five series as follows: Works Nos. 3895–3897 in 1889; 4319–4321 in 1891; 4674–4676 in 1894; 5365 in 1898; and 5761–2 in 1901. The whole class was numbered 159 to 170 by the Mexican Railway. These locomotives (Fig. 32) had cylinders 16in in diameter by 22in stroke, with wheels 3in smaller in diameter than the previous class. The bogie wheelbase was 8ft 3in and the total wheelbase 32ft 5in. With a tube heating surface of 1532 square feet and 180 square feet in the fireboxes, the total amounted to 1712 square feet. The grate area was 33 square feet. Although these engines had the same water and coal capacity, and presented such a massive appearance, they were 5 cwt lighter than the 1883 series, the weight being 92 tons.

The photograph illustrates the engines of 1889–94, but the later series were not fitted with the large spark-arresting chimneys; these were replaced by extended smokeboxes.

Locomotives Built in Austria

In addition to the nineteen Fairlie locomotives taken over from the Tamboff and Saratoff Railway, and the Poti and Tiflis Railway, and the four by the Yorkshire Engine Company, the Russian Government placed an order for a further series of twenty-two 0–6–6–0 locomotives for use on the Transcaucasian railway system. These were built in Austria, and were all delivered by 1886.

Saxon Engine Works Limited

In 1902 the Sachsische Maschinenfabrik vorm. Richard Hartmann of Chemnitz, Saxony, supplied three Fairlie locomotives of the 0–4–4–0 type to the Saxon State Railways for working on metre gauge branch lines connected with industrial plants. These routes had curves as sharp as 30m radius. They were probably the only compound Fairlie locomotives in the world, and had high-pressure cylinders 11in in diameter by 14 $\frac{13}{16}$in stroke driving the coupled axles of one bogie, and the low-pressure cylinders 16 $\frac{13}{16}$in in diameter by 14 $\frac{13}{16}$in stroke driving the coupled axles of the other bogie, the cylinders being located at the inner or firebox end of the bogie frames.

The coupled wheels, placed inside the

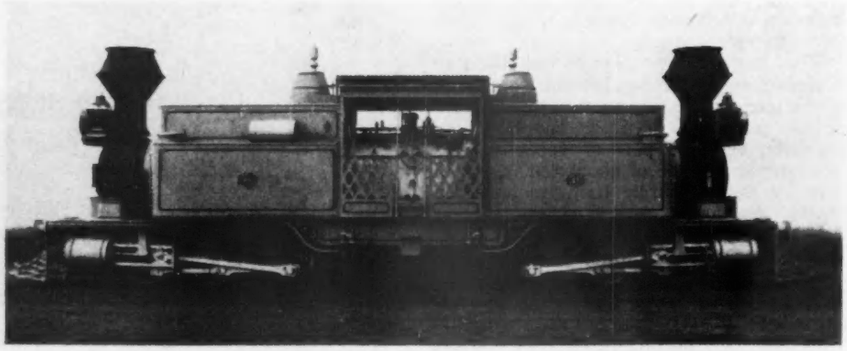


Fig. 32—Locomotive for the Mexican Railway, built by Neilson and Co. in 1894

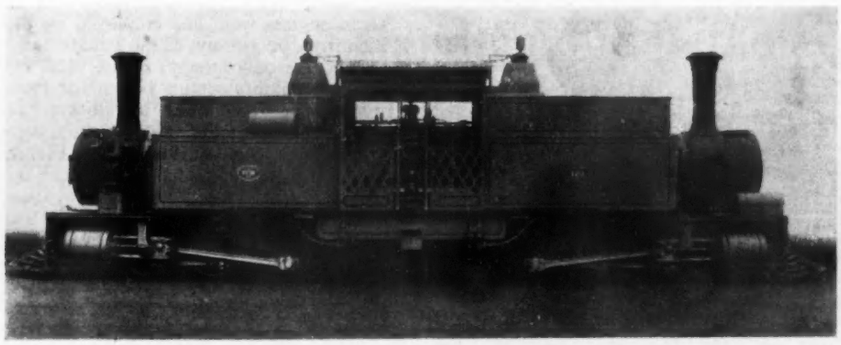


Fig. 33—Mexican Railway locomotive built by the North British Locomotive Company in 1903

frames, were 2ft 5 13/16in in diameter, and each bogie had a wheelbase of 3ft 7 5/16in ; the total wheelbase of the engine being 24ft 11¼in. The boiler carried a working pressure of 199 lb per square inch, and the grate area of the single firebox was 20 square feet. The heating surface of the firebox amounted to 86·5 square feet and that of the two sets of tubes to 876·5 square feet making a total of 963 square feet. The capacity of the tanks was 705 gallons and the bunker held 1½ tons. In full working order the weight was 40 tons 2 cwt.

Since the lines ran for considerable distances along the public highways provision was made for the driver to be always at the front by placing the steam and brake controls at either end. In addition to the central cab, and to enable the crew to pass safely from one end to the other, a large canopy with side panels extended the full length of the locomotive. The motion was also covered in by side flaps. The canopy was removed at a later date when it was decided that the driver should occupy the central cab. As with the earlier Hawthorn locomotives for the 2ft 5½in gauge, the boilers gave trouble, and this, in addition to the inconvenient driving position in public streets, led to their being superseded by Meyer type locomotives.

A photograph of these unique engines appeared in *The Locomotive* for November 20, 1903, page 309, and another photograph, showing the class as running with the canopy removed, will be found in *Die Entwicklung der Lokomotive*, Volume II, published in 1937.

North British Locomotive Company, Ltd.

This company, which was formed in 1903 by the amalgamation of Sharp, Stewart and Co., Neilson, Reid and Co., and Dubbs and Co., commenced the delivery in that year of a series of ten 0-6-6-0 type locomotives to the Mexican Railway. This class, Fig. 33, were very similar to the 1889 class—see Fig. 32—came from the Hyde Park Works and consisted of four built during 1903 (Works Nos. 16028–16031) and two built in 1904 (Works Nos. 16541–2), followed by the final four some years later in 1908 (Works Nos. 18210–1 and 18313–4). The railway numbers of the whole series were 171–180. The cylinders had a diameter of 16in by 22in stroke ; wheels 3ft 6in diameter ; bogie wheelbase 8ft 3in ; total wheelbase 32ft 5½in. The total heating surface was 1712 square feet and the grate area 33 square feet, working pressure 160 lb per square inch. With 2850 gallons of water and 300 cubic feet of fuel, the total weight was 99 tons.

This class was followed during 1908 by two 0-6-6-0 locomotives of much greater power, and these are illustrated by Fig. 34. The cylinders were 17in in diameter and the stroke (like that of the Vulcan engines of 1911) was of the unusual length of 25in. With wheels of 4ft 6in diameter the bogie wheelbase was increased to 9ft 3in, while the total wheelbase was 35ft 6in. With a tube heating surface of 2142 square feet, and 234 square feet in the fireboxes, the total heating surface amounted to 2376 square feet. The grate area was 43·5 square feet and the working pressure 200 lb per square inch. Like the Yorkshire Engine Company locomotives of 1905 for the Junin Railway, the reversing shafts were located at the tops of the tanks and connected to the radius rods of the Walschaerts gear by long swing-links with universal joints at either end. The large water tanks held 3500 gallons, and the capacity of the fuel bunkers was 315 cubic feet. These fine engines had a weight in working order of 120 tons 2 cwt, and the tractive effort at 75 per cent of boiler pressure was 45,166 lb. The Works Nos. were 18315–6 and they carried railway Nos. 181–2.

The Mason-Fairlie

In America the construction of locomotives on the Fairlie principle was taken up by William Mason of the Mason Machine Works, Taunton, Massachusetts, who devoted a great amount of time, energy and thought to the development of these locomotives.

The first was a large 0-6-6-0 double-boiler locomotive named the "Janus" and completed in December, 1871. This had cylinders 15in in diameter by 22in stroke and wheels 3ft 6in in diameter, but it was lack of fuel and water capacity that prevented the engine from being a success. An illustration of it will be found in *The Development of the Locomotive*, by Angus Sinclair, 1907, page 185. After being tried on the Boston and Albany Railroad it was eventually sold to the Lehigh Valley Railroad and used on pusher service on the Wilkes-Barre Summit. The "Janus" was an unsuccessful experiment and thereafter only locomotives of the single-boiler design were built, modified to incorporate bar framing and other American features, and were designated "Mason-Fairlies."

From the following list of railroads that purchased these locomotives it will be found that 150 were constructed at the Mason works between 1872 and 1887.

Name of railroad	Number built
Allouez Mining Company	1
American Fork	1
Atlantic, Mississippi and Ohio	2
Bethlehem Iron Company	1
Boston and Maine	1
Boston, Revere Beach and Lynn	11
Burlington and Lamoille	2
Calumet and Hecla Mining Company	5
Central Iowa	6
Chicago and Michigan Shore	1
Chicago and West Michigan	2
Cincinnati Northern	1
Cleveland and Marietta	2
Covington, Columbus and Black Hills	2
Denver and New Orleans	2
Denver, South Park and Pacific	23
Denver, Utah and Pacific	2
Detroit, Hillsdale and Southwestern	1
Erie	1
Friendship	1
Galveston, Harrisburg and San Antonio	2
Hecla and Torch Lake	1
Illinois Midland	1
Juragua Iron Company, Cuba	2
Long Island	5
Marine	2
Mexican Central	2
Nantasket Beach	1
New Bedford	1
New Brunswick	4
New York and Brighton Beach	2
New York and Manhattan Beach	17
Norfolk and Western	2
North Pacific Coast	2
Old Colony	3
Peach Bottom	1
Providence Warren and Bristol	1
Riviere du Loup	3
St. Joseph Lead Company	1
South Atlantic and Ohio	2
South Florida	3
Stockton and Ione	2
Toledo, Delphos and Burlington	6
Toledo, Wabash and Western	1
Utica, Ithaca and Elmira	1
Wheeling and Lake Erie	14

The "Onward" (Fig. 35) completed on July 1, 1872, for the American Fork Railroad was the first Mason-Fairlie built. This was for a gauge of 3ft, and it had cylinders 10in in diameter by 15in stroke, with 3ft 6in wheels. On the earlier engines of this type the centre pin was held by a cast iron saddle riveted to the boiler, and the tanks and cab were carried on a separate frame bolted to the sides of the firebox. This was satisfactory for the lighter engines, but later on the centre pin was attached to a main frame extending nearly the whole length of the engine.

The first locomotives were equipped with the Stephenson valve gear but on later engines, on account of the closeness of the first pair of driving wheels, the Walschaerts valve gear was adopted in 1874 and Mason was the first American locomotive builder to use this gear. These engines were made in all sizes, weights and wheel arrangements. The smallest had cylinders 10in in diameter by 15in stroke ; with 3ft diameter wheels they weighed 20 tons, and were for a 3ft gauge railroad. Some of the last built had cylinders 18in in diameter by 26in stroke; wheels 4ft 6in in diameter, and a total weight of 66 tons. The records are not clear in the matter of wheel arrangements ; those first constructed were without pony trucks and

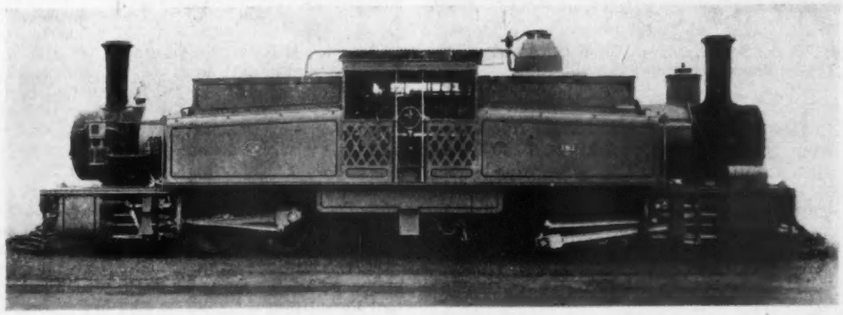


Fig. 34—Locomotive built in 1908 for the Mexican Railway by the North British Locomotive Company

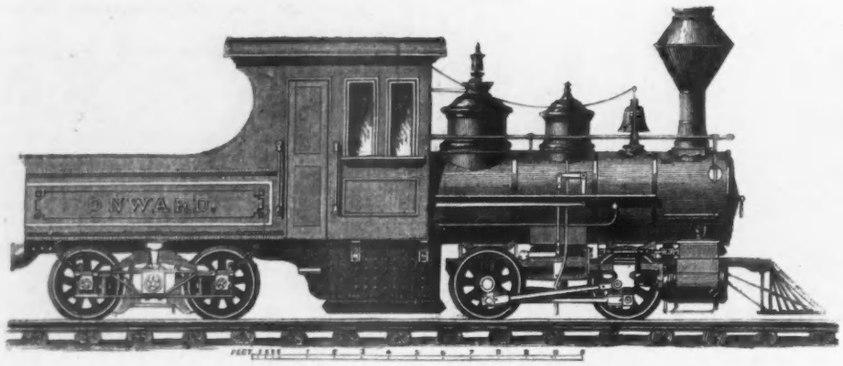


Fig. 35—Mason-Fairlie type locomotive "Onward," built in 1872 at the Mason Machine Works for the American Fork Railroad

were of the 0–4–4, 0–4–6, 0–6–4, and 0–6–6 tank types.

William Mason originally intended these locomotives to be run bunker foremost, but the railroads did not always do this and used them to run either way. With the addition of the pony truck, the 2–4–4, 2–4–6, 2–6–6, and 2–8–6 wheel arrangements were built.

One railroad on which these engines were used exclusively was the Boston, Revere Beach and Lynn Railroad, a 3ft gauge line carrying passengers only, that ran from East Boston to Lynn, about 12 miles and round the Winthrop Loop. The Mason Machine Works ceased to build locomotives in 1890, and the last to be delivered to the B.R.B. and L.R. was in 1887. But this railroad insisted on having "Mason-Fairlie" locomotives and no other type, and so the designs were taken over first by the Manchester Locomotive Works and then by the American Locomotive Company, and almost twice as many more engines of this type were built by these concerns as came from the original Mason Machine Works. With each order the railroad insisted on the same type of engine as furnished by the Mason firm, and they were exact duplicates in every detail.

The last of these were built at the Schenectady works in 1914 (road numbers 24–26), and the photograph (Fig. 36) illustrates one of these handsome locomotives. One feature of particular interest is the reversing shaft mounted across the boiler top and connected to the radius arms of the Walschaerts valve gear by very long swing-links with universal joints to compensate for the movement of the power bogie. This arrangement, in various forms, had been in use as early as 1877. Thus for nearly forty years this design of locomotive was perpetuated and rendered efficient service, and several were rebuilt and reboilered and nearly all were in service when this railroad was electrified in the 1930s. Although the type was never popular in the United States there were several railroads that used them exclusively and to good advantage.

The Pechot-Bourdon Locomotive

It will not be inappropriate to refer briefly to the Péchot-Bourdon type of double-boiler locomotive which did not differ materially from true Fairlies. The design was patented on June 3, 1887, and the following four modifications were claimed:

"A central position for the steam dome ensuring that the steam shall always be taken at a constant height above the water level of the boiler; the use of spring compensation between the boiler and the rear of the bogies in order better to equalise the loads on the axles; simplification of the steam and exhaust piping; attachment of the drawgear near the centres of the bogies."

The twin boiler rested on a plate frame forming a cradle for the firebox. These frames were bolted to two saddles which supported the boiler barrels, but not fixed to them, thus allowing the latter free movement for expansion, while the frame took all traction stresses. The two power bogies, each built up of plate frames outside the wheels, were attached to the saddles by central pivots through which the steam supply pipes passed so that the joints of the pipes coincided with the bogie centres. The cylinders being under the smokeboxes, the exhaust steam connections were very simple, a ball-jointed pipe giving sufficient flexibility.

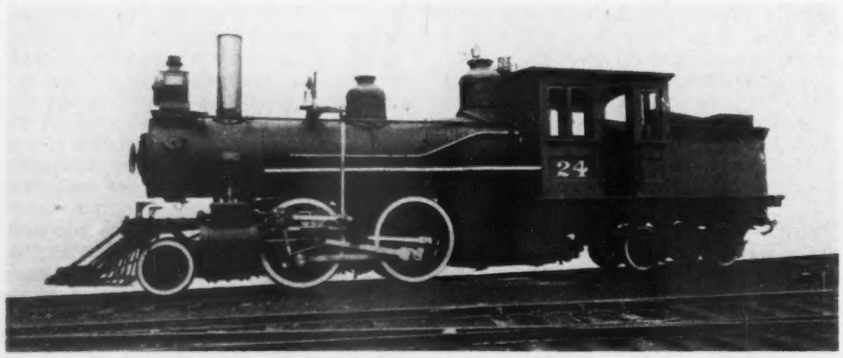


Fig. 36—Mason-Fairlie type locomotive built in 1914 at the Schenectady Works of the American Locomotive Company for the Boston, Revere Beach and Lynn Railroad

These engines were first employed on the French strategic railways of the Toûl fortified zone, and the only attempt to use them for other than military service was at the Paris Exhibition of 1889 when one locomotive was run experimentally. Subsequently, during the Great War of 1914–18 the French Government ordered 100 of them from the Baldwin Locomotive Works, and these engines, built to metric measurements, had cylinders 6·88in in diameter by 9·44in stroke; wheels 2ft 1½in in diameter; bogie wheelbase 2ft 11½in; total wheelbase 12ft 6in; total heating surface 290·481 square feet; grate area 5·102 square feet. The two internal copper fireboxes were separated by a 2in water space. The tanks held 333·23 gallons and the coal bunkers 882 lb.

These locomotives were built in a remarkably short time, the order being received on February 1, 1915 and the last one being shipped on April 24, 1915. Fifteen similar locomotives for the French Government were constructed at the Atlas Works of the North British Locomotive Company, Glasgow, in 1915 (Works Nos. 21183–21197). Built to a gauge of 1ft 11⅝in, and with a length of 18ft 11in, all these locomotives weighed only 12·79 tonnes in working order and were therefore considerably smaller than the Fairlie locomotives of the Festiniog Railway. A photograph of the Baldwin series was published in *The Locomotive* for 1915, page 220.

In conclusion the author wishes to thank all those engineers and railway historians, both in this country and overseas, who have provided information, photographs and drawings.

Institution of Locomotive Engineers

At the annual luncheon of the Institution of Locomotive Engineers, which was held in London last week Dr. Charles Hill said that probably the most spectacular and far-reaching achievement of this country had been the development of the steam locomotive. Britain, he said, had become an exporter of skills and industrial knowledge, and its technologists were in wide demand, whilst great work was being done in the training of technologists for developing countries. The president of the Institution, Mr. R. A. Smeddle, dealt with some aspects of the Modernisation Plan in his response to Dr. Hill's toast of the institution. He said that the progress which had been made showed that the deferred maintenance of the war years was rapidly being overtaken. What was virtually a new railway system was being built in this country, and when it was completed it would be a shop window for British products. The institution, said Mr. Smeddle, was keeping in step with British railway developments, which provided a great scope for valuable and interesting papers.

General Sir Brian Robertson, the chairman of the British Transport Commission, responded to the toast of the guests at the luncheon, and he spoke of the good work being done by engineers. It was not generally appreciated, said Sir Brian, that most of the responsible locomotive engineers in this country had been trained in steam, and in a remarkably short span they had switched over successfully to diesel and electric traction. The British railway system would offer a fine basis of study for the comparison of steam, diesel and electric operation. It was to be expected that there would be teething troubles with new forms of traction as they were introduced, but up till now these troubles had been in minor details and not in major points in design. Sir Brian considered that these troubles should be kept in proportion and not over-emphasised as had sometimes been the case.

Reactor Core Building at Berkeley

AFTER three years' work at Berkeley nuclear power station, which is being built for the C.E.G.B. by A.E.I.–John Thompson Nuclear Energy Company, Ltd., the civil engineering work is nearing completion, the mechanical engineering work is about 75 per cent complete, and the main effort is now concentrated on the reactor installation.

Graphite Core

In No. 1 pressure vessel the graphite core, which contains the fuel elements and control rods and serves as moderator and reflector, is being laid. This core is a structure consisting of about 97,000 pieces of graphite, in the form of blocks and tiles, built up into a regular polygonal prism, 30ft high and 48ft diameter overall. The core proper, that part of the structure in which the fuel elements are located, is 24ft high and 42ft in diameter and is surrounded by the reflector, which has a radial thickness of 2ft and an axial thickness of 3ft at the top and bottom.

The core is built up of twelve layers of 8in by 8in by 30in graphite bricks, successive layers being interleaved with two thicknesses of graphite tiles, keyed together, as can be seen in Fig. 2. The vertical channels for the fuel elements and coolant consist of a 4in diameter hole in each brick and tile, with two diametrically opposed keyways $\frac{13}{16}$in wide by $\frac{3}{4}$in deep, cut in each hole to accommodate the fuel element support struts. Vertical channels, 3in diameter, for control rods, flux measurement and a neutron source are formed by machining quadrant grooves from the corners of certain bricks ; these bricks are earmarked to be grouped in fours so that the four quadrant grooves form a cylindrical channel, as can be seen in Fig. 3. The coolant channels are on a square pitch of 8in.

All the bricks are machined from extruded graphite blocks of nominal size 8·55in square by 32in long, the finished size tolerance being ±0·002in. Between the ends of the bricks in successive layers two rectangular tiles are fitted (Fig. 2). Each tile is made so that the longer side (in plan) is in the direction of extrusion and is equal to the lattice pitch of 8in. The two consecutive tiles in each stack are assembled with their shorter sides at right angles to each other, to allow for Wigner growth.* Under all conditions of growth channel alignment is maintained by the cruciform arrangement of keys and keyways in the tiles and blocks. There is sufficient clearance between each keyway and its mating key to ensure that the columns are supported on the faces of the bricks in all stages of differential growth, to keep the coolant leakage to a minimum. To prevent neutrons from streaming through the gaps that allow for Wigner growth, the bricks in the moderator are rotated through 2 deg. about the vertical axis. The core structure is held together radially by tubular tie-bars with peripheral restraining bands. The tie-bars are made up of mild steel and stainless steel members to give them the same effective thermal expansion as that of graphite.

The core rests on a steel support plate 4in thick which contains 3275 circular holes to locate the fuel element/gas coolant channels, and the whole assembly is carried on cross-braced ring girders. Positive location is effected at the plan centre of the pressure vessel by having the four central columns of the core spigoted to the support plates. To allow for differential expansion between graphite and steel, all the remaining columns of the core rest on ball bearings on the support plates.

Building of the core is carried out under clean conditions. Access to the pressure vessel is obtained via changing rooms and all workers and visitors wear special clothing, including caps, rubber-soled shoes and buttonless overalls, as illustrated.

The setting up of the first layer of the core governs the accuracy of the subsequent stages of assembly. First the area of the support plate is divided into quadrants. In the first quadrant straight-edges are accurately positioned to include a 90 deg. angle (Fig. 1) in which four graphite bricks are positioned on a fixed base to act as a locational centre. Flat movable ball races are mounted on the adjacent cavities to carry the other bricks in the quadrant. When the first quadrant has been filled, the straight-edges are removed and realigned on the second quadrant and the laying proceeds.

The arrangement of bricks and tiles in the first layer is shown in Fig. 2 and the method of handling the bricks can be seen from Fig. 3.

* Ghalib and Southwood, "The Berkeley Power Station," *Proceedings, Peaceful Uses of Atomic Energy, Second International Conference*, Vol. 8.

Progress on Site

The turbine room, a steel-framed building with side cladding of brickwork and glass, is structurally complete and internal finishing is in progress. No. 1 turbine is installed and the stator of the 85MW alternator is now on site. No. 2 turbine is about two-thirds complete.

The circulating water requirements of the station will be 21,000,000 gallons of water per hour, pumped from the River Severn through intake screen chambers situated about 650ft off-shore. These structures, together with a man-access tower, were built inside a circular cofferdam formed of steel box piles. Concreting on the intake screen chambers was completed towards the end of last year and the intake works include an access shaft and tunnel connected to the shore to enable station operatives to maintain the intake works at all states of the tide. Each intake screen chamber is linked with the c.w. pump house by vertical shafts and horizontal tunnels, each tunnel being 1000ft long and 10ft diameter. The tunnels were driven through rock and were constructed with precast concrete segments finished off with "Gunite" lining. The pump house was excavated to a depth of some 70ft from the surface.

The circulating water outfall works have been built within a steel cofferdam 130ft wide and extending 275ft into the river, and include a permanent access bridge to controlling sluice gates and outfall channels, all in reinforced concrete. A baffle wall of steel piles has been built for a length of 1500ft on either side of the intake structures to prevent the outfall water being recirculated through the cold water intake.

The civil engineering works mentioned above are the responsibility of Balfour, Beatty and Co., Ltd. They are due to be completed on July 31 and are now almost finished, well ahead of schedule.

No. 1 reactor (with Nos. 1 and 2 turbo-alternators) is due to be commissioned in the first quarter of 1961, to be followed by No. 2 reactor in the third quarter.

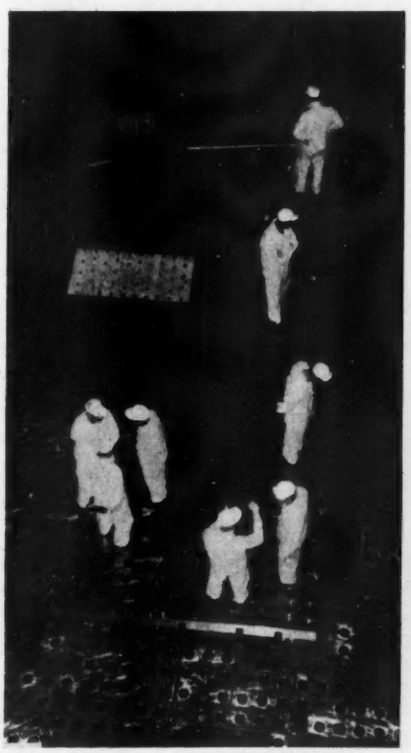


Fig. 1—4in thick steel support plate for graphite core. The straight edges define the first quadrant

Fig. 2—The first layer of the graphite is nearly completed

Fig. 3—Handling one of the "bricks" in the first layer of the graphite core

LETTERS AND LITERATURE

Letter to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

SCIENCE MUSEUM

SIR,—As one who served for many years on the staff of the Science Museum, I read with much interest the leading article on the museum in your issue of February 12. You remark that more of the museum's exhibits are technological than scientific. That, of course, is still true, but of recent years, and in particular since the war, there has been increasing emphasis on pure science, and the proportion of total exhibition area and staff devoted to technology has diminished. When this leads, as apparently it has done, to the transfer of such an immensely valuable historical engineering exhibit as the Turbinia to a provincial museum, one is bound to wonder whether a proper balance is being preserved between the various aspects of the museum's activities. This seems, indeed, an appropriate time to consider the direction of the museum's future development, for as you point out a new building is approaching completion which will add considerably to the exhibition area available; and it has recently been announced that the present director retires in April.

The museum has been in existence for a century, but it is a fact that no engineer has been appointed to direct it for more than fifty years. This is something which the Ministry of Education might well bear in mind when they come to make a new appointment. The last four directors have been in turn, a retired Army officer, a physicist, a chemist, and a zoologist. It is surely desirable from every point of view, not least, one would think, from that of the staff as a whole, that an engineer should be appointed on this occasion. The Ministry might also consider with advantage the composition of the museum's Advisory Council, on which engineering and technology are numerically very inadequately represented.

May I now suggest that serious consideration be given to the transfer of responsibility for the museum from the Ministry of Education to the Department of Scientific and Industrial Research. The Ministry has great and urgent responsibilities in the field of education, but the function of the museum relates only indirectly to the work of schools and technical colleges, and the Science Museum has for long been the Cinderella of the national museums and galleries. In the teaching of science and technology museum exhibits cannot compete with, though they may often supplement, the text book and the blackboard. I submit that the museum's primary business is to provide enlightenment and pleasure to more than a million people of all ages who visit it each year because they are interested in the subjects with which it deals. Incidentally it helps to create a climate of opinion favourable to science and technology, and is a great encouragement to young people to make their careers in those fields. Its importance in the latter connection is obvious when one realises that some 400,000 children visit it annually; but to make it too self-consciously educational would, I believe, weaken rather than strengthen its influence.

Close association with a department accustomed to administration in technical fields, and both sympathetic to and directly involved in the development of science and technology could not fail to be of inestimable value to the museum. There would, no doubt, be some direct benefit to the museum collections, but in this connection I have particularly in mind the periodic temporary exhibitions which were a feature of the museum before the war. It was only through exhibitions of this kind that the museum found it possible to illustrate up-to-date research in any branch of science or technology in a comprehensive way. They were among the most important and educational of the museum's activities and drew large numbers of professional men and students as well as the general public. These exhibitions should be revived as soon as possible with an increase in both scope and frequency, and here the active support of a technical department such as the D.S.I.R. and of the National Physical Laboratory and other research laboratories coming under its wing would surely be of great assistance.

F. ST. A. HARTLEY

Horsham,
March 3, 1960.

Book Reviews

A History of Western Technology. By FRIEDRICH KLEMM. Translated from the German by D. W. Singer. George Allen and Unwin, Ltd., 40, Museum Street, London, W.C.1. Price 32s.

DURING the last few years there has been a spate of books dealing with the history of science and/or technology, and the subject has almost acquired official status in university studies. Most of these books are biased by the outlook of the author on one or other of the ideologies of the day—political, academic, scientific, social, cultural, or economic. This book is entirely different; the giants of the past are allowed to speak for themselves. The whole book, apart from a brief introduction and some slight but important paragraphs to link the various sections together, is a collection of extracts from writings, ranging from Plato to the first atomic bomb, 219 of them altogether. The authors quoted include men of learning and variety of outlook, as well as the professional engineers, scientists, and seekers after knowledge.

This line of approach succeeds brilliantly; a vivid picture of past conditions is presented and the dominant theme—to us at least—is the persistence of human character, whether of the innovators, their supporters and helpers, or of the conventional diehards who opposed them. All the difficulties from which the engineer of to-day may suffer repeat themselves through the ages in much the same way, from the haste and suspicion of political leaders to the restrictive practices of trade guilds and unions. The humanistic value of technology, emphasised so well by Sir Eric Ashby in his recent book,* could not be more vividly expressed than by these voices from the past—the creaking of civilisation's chariot wheels.

The author is the Librarian of the Deutsches Museum, Munich, and one can only admire the great depths of learning from which he has made his selection. The original title of the German book is *Technik : Eine Geschichte Ihrer Probleme*, which has a somewhat different appeal from the English title. The translation is by D. W. Singer, the wife of Dr. Charles Singer, the well-known scientific historian; she is to be congratulated on her difficult task of conveying the—to the layman—obscure variations in the meaning of technical terms to accord with their context. Reference to the original German shows places where changes in phraseology would give a better sense of the original meaning whilst conforming more closely to accepted technical usage, but these are few, considering the difficulties of translating a book of this kind.

Every now and then one comes across gems of wisdom that throw a vivid light on modern conditions. Some of these are so good that a few quotations are imperative. I choose one of 1852 from Professor Redtenbacher, the founder of the German Technische Hochschule tradition of engineering science, and one of 1597 from the military engineer, Lorini, in the service of Cosimo de Medici.

This latter one reads: "I must point out the difference between a purely speculative mathematician and a practical mechanic. This difference is based on the fact that proofs and relationships that are deduced from lines, surfaces and from merely imaginary and non-existent bodies are not completely valid when applied to material bodies, since the conceptions of the mathematician are not subject to those obstacles which are inherent in the nature of the material with which the engineer works."

The former one also has a particularly vivid application to the needs of the present day:

"Drawing is the means by which the engineer can represent his thoughts and ideas with a clarity and distinctness that leave nothing to be desired. A machine that has been drawn is like an ideal realisation of it, but in a material that costs little and is easier to handle than iron and steel .... (it) requires an expenditure of time and effort incomparably less than that needed to build the machine.

"If everything is first well thought out, and the essential dimensions determined by calculation or experience, the drawings of a machine or an assembly of machines can be quickly put on paper and the whole thing as well as the detail can then most conveniently be submitted to the severest criticism. If the whole is found to be unsatisfactory, the drawings are discarded and a second, better set is soon ready. If only certain changes of detail are needed the parts to be changed can be readily

* *Technology and the Academics*, published by Macmillan.

removed and replaced by others that are better. If there is doubt as to which of various possible arrangements is the most desirable, a layout of each is made, they are compared with one another, and the most suitable can easily be chosen.

". . . the measurements and proportions of all the parts can be so sharply and definitely determined from the beginning that when it comes to manufacture it is only necessary to follow in the materials used for construction exactly what is shewn on the drawing. Every part can in general be manufactured independently of every other part ; it is therefore possible to . . . organise the whole business of manufacture in such a manner that each job can be completed at the right time, in the most suitable place, with the least expenditure of time, money, and material, and with an accuracy and reliability that leave almost nothing to be desired. No substantial errors can arise in work organised in this manner, and if it does happen that on a rare occasion a mistake has been made, it is immediately known with whom the blame lies."

Some of the extracts show a vast expenditure of gallant and skilful effort merely to satisfy the vanity or pride of some powerful ruler, a phenomenon not entirely unknown to-day ; but nowhere is there any suggestion by the author of lessons to be learned or inferred ; the extracts are left to let the reader form his own impressions from them.

There are good indexes of names and subjects, a very useful general bibliography, and a complete list of references to the sources from which the extracts are taken. Every engineer should read this book. It will stimulate further study, and at the same time help him to see his own place in the scheme of things, and in the essential continuity of human thought, work, and history.

Transistor Circuits. By K. W. CATTERMOLE, B.Sc. Heywood and Co., Ltd., Carlton House, Great Queen Street, London, W.C.2. Price 70s.

DURING the past few years numerous books have been issued on various aspects of semiconductor devices, but many of them have suffered from being collections of writings not originally intended for incorporation in coherent form as a complete textbook. It is all the more pleasant, therefore, to read in Mr. Cattermole's preface that the book was written with a definite purpose in mind, and then to read the book and find how admirably his purpose has been carried out. One cannot do better than to quote Mr. Cattermole's own words to indicate the class of reader for whom it is suitable : " Its ideal reader is primarily interested in some field of usage ; he is familiar with thermionic valves and electric circuits in general, but need have no more physics and mathematics than is normally consequent on that knowledge." The author goes on to say that the treatment is elementary, but not, he hopes, superficial and this claim is borne out. The preface indicates the general treatment to be followed and brings out two concepts which have perhaps been insufficiently stressed elsewhere ; the transistor's internal feedback and its perfection as a switch.

Chapter One serves as an introduction to set the scene and is followed by a short chapter giving sufficient information about the solid-state physics underlying the devices and their construction to give background without going into detail quite irrelevant to circuit aspects. The next chapters deal with the electrical properties of transistors and the elements of their usage in digital and linear circuits as well as a brief analysis of the common base, common emitter and common collector circuit configurations. Chapters on specific amplifier arrangements then follow and single-stage and multi-stage amplifiers, power and h.f. amplifiers are dealt with in turn in a very thorough yet lucid fashion.

Chapter Nine then covers the subject of supplies and bias stabilisation. In the succeeding chapters which treat negative resistance, binary circuits, waveform generation and counting and timing, it is pertinent to inquire whether, in view of the virtual disappearance of point-contact transistors, the inclusion of an appreciable amount of material about them is justified. It might also be argued that the mixing of junction and point-contact circuits can be a trifle confusing to the uninitiated. A short chapter on modulation, detection and frequency changing concludes the treatment of circuits in this book.

The need for the following chapter on measurements in a book devoted to transistor circuits could be questioned, but some readers may find it of value when wishing to check samples before assessing their circuit behaviour. The final chapter is entitled " Fields of Application," and is a comprehensive survey of existing uses and possible future ones. The main trouble with this sort of chapter is that it is out of date so soon, but at least the keeping of such rapidly-dating material in one place eases the task of bringing it up to date in subsequent editions. Most of the information in the previous chapters will be as valid in ten years as it is now, but there are statements regarding noise factors, maximum junction temperature of germanium transistors and availability of h.f. and n-p-n types which are already not correct.

The above minor points of criticism should not be held to detract appreciably from the value of an excellent book which every circuit designer could study with advantage. The book concludes with a full bibliography, some appendices giving mathematical analyses and an adequate index.

Improved Material Utilisation. Institution of Production Engineers, 10, Chesterfield Street, London, W.1. Price 12s. 6d.

THIS is a report which has been drawn up by the Institution of Production Engineers following the interest shown in the report *Material Utilisation in the Metal Working Industries* published in 1955. Following this earlier report the research committee of the Institution decided that similar investigations in regard to other materials would provide information of use and value to industry. The sub-committee appointed for this purpose gives in the new report a selection of over eighty proved case studies broadly covering the fields of finishes and finishing materials ; packaging and shipping materials ; ceramics, metal powders and plastics ; and ancillary processing materials. The case studies described in this report will be of interest to most managements for even though the cases themselves may not be applicable in their individual establishments, they will stimulate investigations which might well lead to promoting economies and savings in material utilisation.

Books Received

Ingenieur-Mathematik. Vol. I. By Robert Saurer. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, West Germany. Price DM.24.

Berechnung Von Gusseisernen Emaillierten Druckbehältern. By G. Matz and P. Gayer. Springer-Verlag, Berlin-Wilmersdorf, Heidelberger Platz 3, German Federal Republic. Price DM.37.50.

British Standards Institution

All British Standard Specifications can be obtained from the Sales Department of the Institution at 2, Park Street, London, W.1.

THE USE OF STRUCTURAL STEEL IN BUILDING

No. 449 : 1959 (incorporating C.P. 113). Price 15s. and P.D. 3443. Price 5s. The revised standards for structural steel design are considered to be of major importance by the British Standards Institution.

Following the publication in 1948 of the B.S. 449, which is now superseded, the committee concerned decided to initiate a long-term programme of investigation and experimental research to form the basis of a major revision of the standard. Soon after, a second committee was constituted, under the same chairman, to carry out the revision of B.S.153, the standard for steel girder bridges. The results of the studies and researches undertaken for both committees were used in the two revisions. Special care was taken to achieve consistency as much as possible, between corresponding clauses of the two standards.

At a later stage, the incorporation of the revised standard of the Code of Practice, CP.113, was decided upon. This code was originally prepared under the ægis of the Council for Codes of Practice of the Ministry of Works, established in 1942. Much of the information contained in both B.S.449 and C.P.113 was the same and, following the transfer of the Codes of Practice Council from the Ministry of Works to the B.S.I., it was agreed that the two documents should be amalgamated and issued as a single publication under the main reference B.S.449.

The basis of " simple design " adopted in the earlier editions of B.S.449 has been retained ; but, as a result of the investigations carried out, it was found possible to modify certain design rules to give a more economical use of steel in the larger structures. Permission to use " semi-rigid " and the " fully rigid " methods of design is still maintained, with the proviso that the limiting stresses will not exceed those permitted in the standard. The use of methods of " plastic " design is also recognised, provided an adequate load factor is selected and deflections under working loads are not in excess of the limits specified in the standard. For these special methods, it is implied that design will be carried out by engineers fully conversant with the principles involved.

In the case of " semi-rigid " design, reference is made to the " Recommendations for Design " in the final report of the Steel Structures Research Committee, 1936, and which has been reprinted and is available from B.S.I. under the reference P.D.3343.

Apart from alterations caused by amalgamation with C.P.113, the main differences between the present revised standard and the 1948 issue can be summarised as follows:

(1) In order not to restrict the applications of the standard to the loadings recommended in the Code of Practice, C.P.3, Ch.5, " Loading," the clauses in the standard for dead and imposed loads have been omitted, but reference has been made to the code, which has now been amended to include also requirements for wind loads on unclad structures. The allowances for dynamic loading have been retained in the standard.

(2) In Part 4, " Design and Details of Construction," the clauses for members subject to bending, axial compression and axial tension have been rearranged in separate groups, each containing the basic information necessary for design. In the section on bending, separate tables have been added for the assessment of the permissible stresses in compression in (*a*) simple or compound beams made of rolled sections, (*b*) plate girders.

(3) Data on the use of tubular members in building, covered by Addendum No. 1, P.D.1736, are now embodied in the text of the standard.

(4) The design clauses for welds and welding have been curtailed and reference has been made instead to the appropriate British Standards. An important addition consists of a section, based on B.S.2645, specifying the tests to be used for the approval of welders for general and special structural work.

A supplement to the revised standard, now in preparation, will relate to the use in building of cold rolled sections in light gauge sheet and strip steel.

Publication of this standard was delayed for some time following an announcement by the heavy steel industries that the specified yield stresses for mild steel in normal use in structures had been increased in certain thicknesses by a maximum of 5 per cent. It was, therefore, decided to make all the alterations to the tables of permissible stresses and all consequential amendments in the text made necessary by the change in yield stress. The revised B.S.449 has thus been brought up to date with regard to the properties of the mild steels mostly used in structures. A similar change has been made in one of the grades of steel tubing recommended for tubular structures. Corresponding changes for the steels specified in B.S.153, " Steel Girder Bridges," will be the subject of a comprehensive amendment to be issued shortly.

Proposals for a Thames Flood Barrier

Last week the Minister of Housing and Local Government presented to Parliament a report on the feasibility of building a movable flood barrier across the Thames in Long Reach. The purpose of the barrier would be to close the river some hours before the occurrence of an exceptional tidal surge, thus preventing flooding from this cause in the metropolitan area. The following article, after an introduction, comprises abstracts from the report describing the alternative designs proposed by the two firms of consulting engineers, Messrs. Rendel, Palmer and Tritton, and Sir Bruce White, Wolfe Barry and Partners.*

THE phenomenon of the tidal surge in the North Sea will be well known to most of our readers, particularly on account of the disaster of 1953. On that occasion it so happened that the surge did not quite coincide with high tide in the Thames estuary, and the upland flow at the time was low. Nevertheless, the river lapped the parapets of the embankments in Central London. Thus, a slightly higher river level would have caused extensive flooding in the boroughs of Fulham, Wandsworth, Battersea, Lambeth, Stepney, Poplar, Greenwich, Westminster, Bermondsey and Woolwich. On that occasion the tide was 6ft above its predicted level at Southend, though the actual surge height was a maximum of about 9ft, two hours or so before high water. The upland flow was 2500 cusecs. An extreme upland flow would be around 40,000 cusecs, and a flow of 20,000 cusecs would increase the level at London Bridge by 9in, it has been shown.

After the 1953 disaster, the Waverley committee was appointed to examine sea defences. Its report was published in May, 1954, and, as a consequence, a technical panel was formed to study flood defences in the Thames, and in particular the feasibility of a movable flood barrier which could be closed to prevent surges travelling up the estuary to the metropolitan area. The panel advised that consulting engineers should be appointed and in July, 1956, the Minister of Housing and Local Government appointed the two firms named in the summary. In February, 1959, the Minister told the House that he had received reports from these firms and was arranging to publish a summary of their views. This was done last week.

Broadly speaking, it is now held that a barrier is a practical, if difficult, proposition to construct, at one of two sites in Long Reach, and is preferable to the alternative course of raising existing embankments and defences, which was studied by the panel. To quote the report : "The Government now proposes to consult the local authorities, river boards, conservancies and other bodies concerned in the Thames Estuary, both above and below Long Reach. These consultations will cover all aspects of flood prevention in the estuary, including the barrier proposal. After they have taken place, it will be possible to establish how widespread is the support for embarking on the barrier proposal, and to consider the arrangements under which such a barrier (if it goes forward) might be built, maintained, operated and paid for."

The Consultants' Terms of Reference

The consultants were asked to report on the practicability of a movable barrier in Long Reach, either with or without a road bridge and, if necessary, to suggest an alternative site. For navigation, an unobstructed fairway was clearly considered preferable, but it was suggested that the specification should call for two clear central spans each of 500ft, with a vertical clearance of 220ft, with the barrier not in use. Side spans would cater for barges and light traffic, dimensions of not less than 250ft span and 50ft clearance being suggested. Protection against surge levels 6ft higher than those experienced in the 1953 disaster was specified.

Basic Design Data

The consultants' report stipulates the following working levels for design based on model tests : Southend +20ft ; Tilbury +21·5ft ; Long Reach +22·6ft ; Tower Pier +24·2ft ; Richmond +21ft. It explains the complications to conditions and levels downstream of the barrier caused by its operation ; explains the method of operation based on closure some hours before the surge, using the warning system ; and emphasises that protection from upland floods is not given.

Some principal design data are : river width 2250ft (site 1) or 2441ft (site 2) ; river bed level −22ft O.D. ; mean velocity of flow, spring tide, 4ft per second ; maximum surge 6·75ft per second. An upland flow of 40,000 cusecs would raise upstream level by 4ft if the barrier were closed for six hours.

Alternative Structures Proposed

The following abstract from the consultants' report is confined to a technical description of the alternative structures proposed.

The essential requirements of a movable barrier are :

(i) The barrier must be capable of closing the river against a tidal current of 7ft per second.

(ii) It must offer the least obstruction to shipping in its open position.

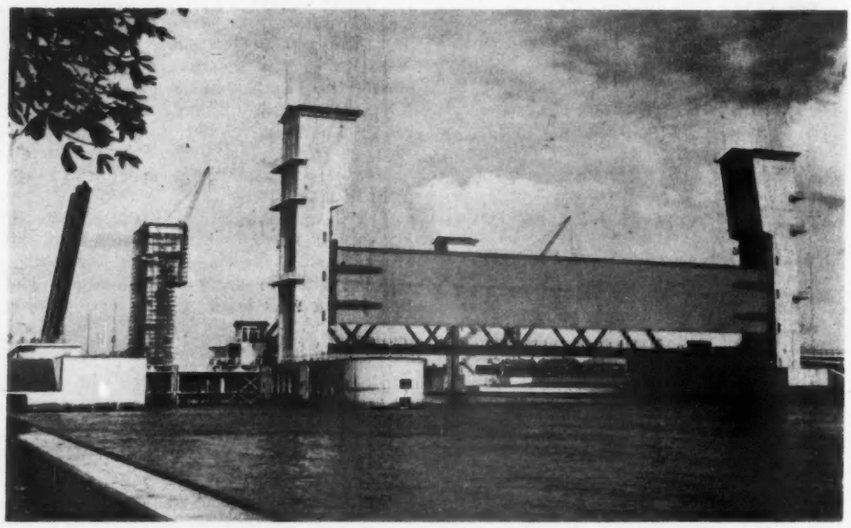
(iii) It must not cause undue silting or scouring of the river bed.

(iv) It must withstand a differential head of 20ft with a maximum depth of water on the downstream side of 65ft.

(v) It must be dependable in operation and the operating gear must be readily accessible.

The types of barrier considered were : (*a*) The vertical lifting type with overhead girder spans raised and lowered between towers, the final closure being effected by the lowering of gates to the river bed from the bottom chords of the bridge spans ; (*b*) The swing bridge type which would pivot on the piers, the final closure being carried out in a similar manner to the type (*a*) above ; (*c*) The retractable type of barrier in the form of floating or sliding sections which could be launched into the river from either side ; (*d*) The permanently submerged type which would normally be housed on the river bed and would rise up from the bed when closure was necessary ; (*e*) The hinged gate types either of the mitre or straight sill design ; (*f*) The bascule type with rising girder spans.

The consultants rejected the submerged, bascule, and hinged gate types. The submerged type was attractive as no piers would be required in the river and, as it would be housed on the river bed on a prepared base, there would be no obstruction to shipping. The barrier, however, would be subject to corrosion and special measures would have to be taken on that account. The working parts would be inaccessible, and there would be no knowing whether silting had occurred or whether the barrier was in immediate readiness to be brought into operation. Any work that might have to be done on the barrier would have to be by divers or by diving bell or complete sections would have to be floated away to a dry dock. In the bascule type, the problem of providing adequate anchorage for the bascule



The surge barrier on the Hollandsche Ijssel river near Rotterdam is the only modern structure resembling the proposed Thames barrier in its function. A clear opening of 80m is controlled by a massive gate. A standby gate is to be provided behind it. Shipping passes through the lock on the left, even when the barrier is closed. There is a road bridge with a bascule span at the lock. See "The Engineer" of October 2, 1959, page 351, for a full description

* *Technical Possibilities of a Thames Flood Barrier.* Cmnd. 956, H.M. Stationery Office. Price 3s. 6d.

spans would be tremendous and would be likely to rule out such a scheme. The swing bridge type would offer a better solution. Similar gates in smaller sizes to those proposed for the hinged gate type have been widely used, but attempts to build swing and mitre gates to suit large openings have proved unsatisfactory for various reasons. To keep the pintle loads reasonably low, the gates would have to include buoyancy chambers, and the swinging of the structure into position in a strong tide would involve opposing the force of the river through the barrier handling mechanism. The forces to be controlled would be of a high order and would need to be applied through considerable distances.

The consultants therefore devoted their attention to the three remaining types.

The Lifting Barrier

Three piers, each about 75ft wide, would support the main towers 320ft high. Between these towers counter-balanced lifting bridge spans would be suspended, and the upstream lower chords of each span would carry hinged gates. The two central openings would give a clear waterway of approximately 480ft.

A concrete sill 90ft wide with stops would be provided between the piers to receive the thrust of the gate frames when swung into the river from the counterbalanced lifting spans, and additional scour protection in the form of concrete slabs laid on the river bed would, if necessary, increase the sill width to 160ft.

The piers would have to transmit the portion of the horizontal load taken by the lifting spans to the foundation, besides supporting the superstructure, and they would be taken down into the chalk. They would be constructed of mass and reinforced concrete and the sill would also be mainly of mass concrete founded either in the chalk for the central spans or in the ballast for the smaller 240ft side spans.

Sheet pile cut-offs would be provided upstream and downstream of the sill and a tunnel for access and services would be incorporated in the sill.

The lifting spans would be K-braced trusses constructed mainly of high tensile steel to keep the weight as low as possible.

When the waterway was open, the lifting spans, with the gate frames housed under the bottom chords in a horizontal position, would be in their maximum raised position at the top of the towers affording a clear passageway for shipping.

When closure was necessary, the lifting spans would be lowered to a level just above the downstream anticipated maximum water level of +22 O.D. (Newlyn) and locked in position, after which the hinged gates would be swung downwards into the water from the bottom chords, to take up their position against the river bed sill stops.

The gates would be designed with fixed skin plates for the top halves and with rolling gates for the lower portions so that gradual final closure could be effected. The gates themselves would be units of 74ft high by 34ft 6in wide. Any reverse head on the gates during a falling tide would be automatically relieved by the hinged gates coming free of the sill.

The side spans flanking the navigation spans would be of the ordinary vertical lift type operated from a fixed overbridge.

The Operating Mechanism.—The spans would be lowered by gravity and automatically controlled by hydraulic cylinders acting as " dashpots," the cylinders being placed in the centre of each span and connected by ropes through sheaves to the four corners of the span and thence to the towers. Electric hoist winches would also be provided and as an alternative the bridge spans could be lowered under the control of the winches.

The hinged gate frames would also be lowered by gravity against hydraulic dashpots through sheaves attached to rams and for raising the gates hydraulic power would be provided by an electrically-driven pump with a standby unit and duplicate bus mains on each span. For raising the gates and lifting spans the hydraulic power and electric hoist winches would be brought into use, the operations being synchronised.

The control of the spans and gates would be pneumatically operated from a control house located on shore. Indicators in the control house would show the exact positions of all the units. It is estimated that the lowering and locking of the spans would take about twelve minutes and the gates could then be lowered in a further fifteen minutes.

The cost of this barrier would be £15,000,000 to £17,000,000.

The Swing Bridge Type of Barrier

The pier widths of the order of 75ft and the two central spans of 480ft would be retained in this design, with 240ft clear side openings. The foundation work, including the piers and sills, would be similar to that described for the lifting barrier.

Three lattice girder swing spans would be pivoted on the three piers and in the waterway open position they would lie parallel to the river extending 240ft from the pier on the upstream side and a similar distance on the downstream side. Provision would have to be made for securing the arms in the open position on extensions to the piers, and these would have to be of sufficient weight and strength to withstand accidental impact by passing vessels, to avoid damage to the spans.

On closure the spans would swing about their pivots, meeting in the middle of the two central waterways where they would be locked in position. At the same time the upstream arms of the two end spans would swing across the two 240ft side openings.

Hinged gates would be housed under the bottom chords of the lattice girders, their design and operation being as described for the lifting barrier. They would be lowered into the river to come up against the river bed sills for closure, and when not in use they would be housed horizontally under the lattice girders. They would be designed to resist the horizontal load imposed by a differential head of 20ft resulting in a water pressure of 34 tons per foot run.

The swing spans would be of high tensile steel girder construction of conventional design and vertical upper and lower K-braced web systems. On the piers the spans would be carried by bogies on circular tracks guided by central radial roller bearings carried in steel housing built into the piers. Provision would be made for the locking anchorages to permit full articulation under wind and water load and to prevent rotation of the spans as a whole when closed.

Operating Mechanism.—The power required to swing the spans from the open position into alignment across the river would be provided by air/hydraulic rams operated from compressed air reservoirs. The rams would be double acting in order to reverse the procedure on opening. The air reservoirs would be replenished by electrically-operated air pumps but the reservoirs would be of sufficient capacity to allow one opening and one closure without replenishment. The speed of operation would be controlled by valves with over-riding proximity controls. The gate frames, as for the lifting type of barrier, would be lowered by gravity under the control of hydraulic cylinders and they would be raised by electrically-driven hydraulic pumps.

The cost of this design would be £13,000,000 to £15,000,000.

The Retractable Barrier

This scheme would provide for a horizontal retracting barrier closing two 500ft and two 250ft clear openings. The barrier would take the form of two lattice steel girders approximately 930ft long and 83ft wide, normally housed one on each side of the river in docks constructed on a line at right angles to the river. In addition to the docks, the sub-structure work would include the abutments with one central and two intermediate piers, and a continuous sill in the river across the four openings.

The three piers and the two abutments would have openings in them of a sufficient width and height to allow the two 930ft retractable spans (to be launched from both sides of the river) to pass through the abutments and piers, to meet in the middle of the river. The barrier units would be partially submerged when launched and once in position the framework of the barrier would act as a horizontal beam spanning between the piers and the abutments. Flap gates would then be lowered from the bottom of the barrier to the river bed sill thus closing the waterway. Provision would be made to prevent silt accumulating in the pier openings and the docks would be provided with gates so that the barrier units could be maintained in the dry when not in use.

Operating Mechanism.—There would be no rails on the river bed, the support for the barrier units coming from wheels housed on the top of the docks, the abutments, and the piers, and revolving under rails fixed in an inverted position on each side of the barrier units. These launching wheels would each be incorporated in the ram of a hydraulic jack so that, by suitable hydraulic coupling of the jacks, a proper distribution of wheel loading on the barrier units could be ensured. In addition the system would provide a suitable means for correcting deflections of the barrier units when they entered the piers.

Buoyancy tanks would be incorporated in the structure to relieve it of a large proportion of the vertical weight and to minimise the load on the launching wheels. Propulsion of the barrier units would be by electrically-driven winches located at the dock entrances. Lateral control of the barrier during launching would be effected by side wheels integral with hydraulic rams of the same pattern as in the system for supporting the weight of the structure ; those side wheels would be located in the dock sides and in the abutments and piers. A feature of the hydraulically adjustable wheels would be that, when launching was complete, the wheels would be retracted out of engagement with the barrier girders, which would then settle against heavy duty supports in the form of conventional bridge bearings.

The cost of this barrier would be £15,500,000 to £17,500,000.

Comments upon the Three Designs

The lifting bridge design can be closed by gravity and only in the opening and lifting of the barrier is electric power necessary. Should there be a power failure, however, the gates would automatically open when a reverse head was created by the falling tide so that there would be no risks involved in a power failure and the worst that would

happen would be that shipping would be held up until the power was restored. The lifting type of barrier is claimed to be more dependable than the other types and has the further advantage that the length of the piers is kept to a maximum of 160ft which would interfere the least with navigation.

It is to be observed, however, that the barrier, each central span of which would be counter-balanced and would weigh approximately 5600 tons, would have to be lifted vertically approximately 200ft and that in the open position the barrier units would remain suspended 220ft above the datum level. Maintenance would be rather more difficult and possibly more expensive than with the swing and retractable types.

A roadway could be incorporated in the design to be available to road traffic at all times except when it was necessary to close the barrier. The additional cost, excluding land acquisition, but including approach viaducts, would be of the order of £6,000,000 on 1958 prices.

As previously explained the swing bridge spans of the second design would be operated by air/hydraulic rams fed from air reservoirs of sufficient size to provide for the closing and the opening of the barrier without recharge. The gates would be closed by gravity but electric power would be needed to open them.

Thus, so far as the possible failure of electric power is concerned this design is on a par with the lifting bridge type of barrier. It has the advantage that the gate units would be housed in the open position only a few feet above the high tide level and consequently the units would be easily accessible at all times for the purposes of inspection and maintenance.

The main disadvantage would be that in the open position the girder spans would cover 670ft in the direction parallel to the river and this might form a greater hazard to shipping. Also the stresses developed in the pier pivots would be high, but this is not thought to be an insurmountable design problem. A roadway crossing could not be incorporated in this design as closing the bridge spans would interfere with the shipping.

The retractable barrier offers great advantage in the fact that the units when not in use would be housed in a dry dock on both sides of the river. The shipping openings would also be 500ft wide instead of the 483ft in the other two types. Electric power would, however, be necessary both for the closing and the opening of the barrier and, even with the ingenious methods that have been considered to afford control and adjustment of the units during launching and retraction, there remains the doubt whether the operations would be smooth and without difficulty. From the point of view of the launching across the fast flowing river the design would be new and untried and great reliance would have to be placed on the calculation of the forces due to the water pressure. Dangerous vibrations might develop due to resonance with eddies in the river flow, and undoubtedly if this design was to be considered further, very extensive tests and experiments would have to be carried out to prove its practicability.

Management of Research

By LORD NELSON OF STAFFORD*

A paper by Lord Nelson of Stafford on management of research was presented on March 4 at the 1960 International Congress of Scientific Management which was held in Melbourne, Australia. This paper deals with the subject under four main headings, namely, the direction, financing, staffing and organisation of research. The main conclusion is that, as research is an integral part of modern industry, managerial judgment and business acumen are vital qualities in the management of it. Abstracts from the paper are reproduced here.

ACCEPTING the need for research as essential to modern industrial life, I propose to consider four main aspects, namely, direction, finance, staff and organisation.

The Direction of Research

The direction of research involves strategy, that is, it refers to the major policy questions which are involved in relating research to other activities—how much research should be done; what proportion of available resources should be devoted to research; what kind of research should be done; these and similar questions constitute the problems of direction. For the purpose of this discussion I propose to use the following definitions:

(1) Pure research is concerned with adding to human knowledge with no other object in mind than the search for truth.

(2) Applied research is concerned with solutions to specific problems in defined fields of activity related to known needs.

(3) Technical development is concerned with the introduction of new products and processes and the improvement of existing ones. In fact, development deals with objects whereas research deals with subjects.

Balance Between Research and Development.—A major responsibility falls on management to ensure the proper balance between various levels of research within the organisation. On the one hand it is useless to have a staff of high powered theoretical scientists producing far more information than can be absorbed, and on the other hand, it is dangerous to be pushing on with the development of highly technical products if the flow of new fundamental information coming into the development department is inadequate.

To give two instances from my own experience. When I took over The English Electric Company in 1930 I found that my predecessors had decided to abandon production of diesel engines because the volume of business foreseen at that time was insufficient to pay for the research and development expenditure incurred. I reversed that decision because I was convinced that the diesel engine was the most efficient thermo-power unit available at that time, and this would soon be recognised by people who needed power units of limited size. In due course this recognition was achieved and to-day diesel engines represent a very large and profitable turnover.

At about the same time I discovered that large sums were being spent on research into high-tension direct-current transmission. Because the Central Electricity Board in England at that time had recently adopted alternating current as standard it seemed to me that there would not be sufficient business in direct current transmission for some thirty to fifty years and so I decided to discontinue this branch of research.

Balance of Expenditure.—The second major problem concerns the amount of effort to be spent on research; thus in Great Britain the percentage of turnover devoted to research and development varies enormously from industry to industry as is shown in Table I.

Within industries, of course, the variation between firms is considerable; different firms react differently to the same market conditions, and it is not uncommon to find the following approaches among competing companies. One firm will maintain expensive research and development facilities to ensure that its product is technically the best and most up-to-date, and to ensure its ability to meet any special requirements of its customers. Another will do less pioneering and research but will concentrate on adequate testing and first-class servicing to build up a reputation for reliability. A third will spend a minimum on research and development, limit its range to a few standard models and concentrate on producing these well and cheaply, with economy as its principal competitive asset. Any company entering a market has to consider the strength of competition from these various different approaches and the attitude of the customer, and must judge how much it is prepared to spend on research, development and other technical facilities in the light of its own assessment of the market.

In the heavy capital goods industry, with which I am most directly concerned, one finds the customers themselves vary in their reactions. Thus the British and North American electricity authorities, for example, with their very large networks give considerable weight in awarding contracts to the supplier's technical standing; in particular, to the effort they devote to forward thinking and research. The electricity authorities of many smaller countries, on the other hand, particularly those where there are balance of payment difficulties and where there is less tradition of engineering, will be more attracted by low prices when awarding contracts. Many railway and transport authorities, steel works and similar user

Table I—*Expenditure on Research and Development by Various Industries in the U.K.*

	Expenditure	Percentage of net output	Total qualified staff employed in research and development	Expenditure per qualified man
	Millions			
Aircraft	£80·0	35·0	3,600	£22,222
Electrical engineering	£33·4	6·8	7,557	£4,420
Chemicals	£23·5	4·8	7,002	£3,356
Precision instruments and jewellery	£1·9	2·3	535	£3,551
Vehicles and components	£7·9	1·7	910	£8,681
Non-electrical engineering	£15·3	1·8	3,389	£4,515
Bricks, pottery and glass	£1·8	1·0	565	£3,186
Food, drinks and tobacco	£2·6	0·6	1,108	£2,347
Paper and printing	£1·9	0·2	440	£4,318
Clothing	£1·0	0·1	14	£7,143

Source: D.S.I.R. Report, "Estimates of Resources devoted to Scientific and Engineering Research and Development in British Manufacturing Industry—1955."

* Chairman, The English Electric Company, Ltd.

industries are more interested in equipment which is thoroughly reliable rather than the most up-to-date technically or the cheapest in first cost.

National Considerations.—The gross national product of any country is finite and from it has to be found resources for consumption, investment, research, development and so forth, and a comparison of expenditure of some leading countries on research is given in Table II.

TABLE II—*Expenditure on Research in Various Countries*—1956

	Expenditure, million	Percentage of gross national product	Government contribution to total, per cent	Number of scientists
U.S.A. ...	$9000	2·3	61	157,000
U.K. ...	£300	1·8	75	47,000
Estimates for other countries' expenditure in terms of gross national product are as follows :				
Canada ...	—	1·0	—	—
Germany	—	0·8	—	—
France ...	—	0·6	—	—
Australia...	—	0·3	—	—

Sources : For U.S.A. and U.K., D.S.I.R. Reports. For other countries, G. L. Bailey ; Presidential Address to Institute of Metals.

With countries as with industries the distinction between research and development is not always clear to the outsider. Many people, for example, were ready to believe that Russia leads the world in science because she launched the first earth satellite and the first missile to land on the moon. Although these achievements represented tremendously important feats of engineering involving sound organisation and the application of modern technological methods, in themselves they do not represent scientific advances. In the same way it is often mistakenly assumed that an undeveloped country can catch up with the highly industrialised countries of the west by increasing its expenditure on research or by turning out more science graduates whereas adequate numbers of men skilled in a quite different field are required. In India to-day, for example, foremen, planning engineers, and a whole range of industrial technicians are needed much more urgently than pure scientists.

Financing of Research

I have emphasised that one of the primary strategic questions facing management is the proportion of available resources that can be allocated to research.

Within industry one expects a higher expenditure on research by the larger companies and indeed it has been estimated that in the U.S. 70 per cent of research and development is done by firms with over 5000 employees, whereas these firms count for less than half the total output. A few figures will show that this is inevitable. From Table I it is possible to calculate that research costs about £4000 per annum for every qualified research worker, so that the smallest possible research laboratory employing only one graduate will involve this order of expenditure. In fact, allowing for facilities needed for one man that can be shared with additional men, it is probably reasonable to say that the minimum a company can spend on research is £5000 to £10,000 per annum. Since the average research expenditure for British manufacturing industry is 1 to 2 per cent of output, it follows that any normal manufacturing company with a turnover of less than £500,000 per annum cannot expect to have its own research establishment.

In practice, a research worker cannot efficiently work in isolation and needs the support, stimulation and cross fertilisation of other workers. A self-sufficient team, therefore, usually contains at least fifty people, of whom fifteen to twenty are of graduate level, and the cost of such a team could hardly be borne by a company whose turnover is less than £5,000,000 per annum. It has been estimated that 80 per cent of the research workers in the United Kingdom in fact work in laboratories employing fifty or over, and this agrees with American experience that most research is undertaken in large companies.

Basis of Allocation for Research.—Thus, large companies, spending upwards of £100,000 per annum on research and development, have to decide what proportion of this total spend should be allocated to basic research and how such expenditure is to be controlled. In practice, control is comparatively easily achieved through the size of the team. The expenditure per graduate employed is remarkably constant from year to year and from establishment to establishment and so, by controlling the number of qualified research workers, it is possible to control the expenditure within comparatively narrow limits. Budgeting then largely consists of allocating the time of qualified workers between different fields of study.

Whereas development spending can be charged against products and the return on such expenditure calculated, the allocation of money to research is more a matter of faith than of economics. On the other hand, in certain industries such as the electrical industry, the importance of innovation is greater than it is often realised. One great heavy-electrical company has calculated that, of its sales in 1957, 60 per cent were of goods not even heard of in 1947. If the year 1930 had been taken, the share would be no less than 90 per cent.

In allocating money for basic research, the following advantages need to be considered :

(1) Research can provide the new ideas that enable a company to establish a lead in new products.

(2) Research provides ideas that are absorbed and used by the development departments.

(3) Research has a prestige value to a company which is of commercial value with customers who are technically minded, makes recruiting of first-class technical staff easier, and boosts the morale of existing staff.

Finding the Money.—In most countries the greater part of scientific research is paid for by Government departments and mostly by Defence departments, irrespective of where the research is done, whether in universities, Government departments or in industry, and this is indicated in Table II. A high proportion of such research is paid for by defence departments but fortunately they permit and often encourage a high level of pure research.

In my own company we have divided our research budget in the heavy electrical field into three sections :

(1) Basic research of general interest with no immediate purpose in mind.

(2) Special investigations into specific problems submitted from other departments of the company.

(3) Research and investigations commissioned by outside bodies, such as Government departments or large customers.

We believe that the best balance is achieved when the level of expenditure on the first two sections is approximately equal and that the third section which fluctuates widely should be of the same order of magnitude. The first section is paid for by the company as an overhead, the second section is charged against the appropriate product department commissioning the investigation and the third section is paid for by the contracting outside body.

If the share of (1) or (3) is too low, this indicates that we are not thinking far enough ahead, so that the quality of the work under the other two heads will inevitably suffer. If the share of (1) is too high, this suggests that our research department is failing to attract work from outside and is losing touch with the practical world. These figures, therefore, are a useful barometer as well as a practical measure of control. I should emphasise that the 1 : 1 : 1 ratio mentioned here is not of universal application, but for each set of circumstances there is an appropriate ratio. In general terms, basic research expressed as a ratio of all applied research carried out in a company, wherever it is done, is of the order of 1 : 10.

Time Scale of Budgets.—In considering research work it is necessary to take a long-term view and this cannot always be done within the framework of annual budgets. For instance, several years ago, the United Kingdom Government asked my own company to undertake the design and development of guided missiles because of the experience we had gained and the research we had undertaken in the basic fields of radio communication, supersonic flight, electronic control and propulsion. In the same way a few years later, we were asked to enter the field of atomic power reactors and at the present time we are investigating aspects of high-voltage transmission of power by direct current. In each of these cases there is a programme of many years which involves the following phases :

(1) Research into the sciences involved, together with feasibility studies.

(2) Applied research on the more useful ideas emanating from the first phase, together with basic research into the problems revealed by feasibility studies.

(3) Development of components suggested by research.

(4) Production of prototypes.

(5) Commencement of manufacture.

Considerable research effort is required throughout all these phases and in providing any sort of budget it is essential to envisage the progressive nature of such work. Research cannot be regarded as a luxury which can be switched on and off as the company's profit position fluctuates and there is no doubt that many major products in the defence and capital goods fields have suffered by the tendency of Governments to handle research and development projects within the framework of an annual budget designed to fluctuate with the country's economic state.

The practical management of research, therefore, requires a firm grasp that will, on the one hand, maintain the continuity of funds for research in good times and bad and, on the other, demand from the research departments a realistic attitude towards money. This involves in particular regular reviews of the progress of each research project to assess its eventual practical applications.

Return on Research Investment.—The appropriate method of charging for research is extremely complex. In each of the projects which I mentioned, namely, guided missiles, atomic power and high-voltage transmission, the ultimate strategic objective is that we should manufacture equipment to keep our factories occupied to provide regular and stable employment for our workpeople and to earn a profit.

In considering whether to enter into one of these major new fields and deciding where the money is coming from for the initial

research and the subsequent development, it is necessary to consider :

(1) How far the project can be regarded as self-supporting in its own right.

(2) How far success in this field helps the company's business as a whole and may therefore be reasonably charged as an overhead expense.

(3) What help can be obtained from outside sources, e.g. from Government sponsored contracts.

In practice there is a limit to the application of the second process and most of these projects must be made self-supporting. Excessive price competition which forces companies to sell goods without making an adequate recovery for research and development will inevitably in the long run lead to restrictions on research and the slowing down of the rate of advance. It would be ironical if private enterprise and free competition were to create the very conditions that would force industry to limit its research and development so that in the long run a greater proportion of this had to be undertaken at Government expense.

Staffing

I have always believed that men are much more important than organisations and nowhere is this more true than in the field of research.

The essential function of management in the research field is to attract the brilliant men and to provide the environment in which they can give of their best.

Inducements.—Research workers undoubtedly respond to leadership and once a laboratory has a leader who becomes well known in a particular field of science, this, too, serves to attract the first-class men who are essential for true research work.

One of the problems of dealing with research staff is that of status. Research scientists entering industry sometimes find it difficult to understand why people of much lower educational attainments and apparently lower social status should enjoy greater privileges than themselves in the industrial hierarchy and this problem is often particularly acute where a research laboratory is in close proximity to a works.

There are two quite separate problems here. The first is that the research scientist brought up in the sheltered atmosphere of a university does not understand the workings of industry and he has to be taught that the salesman and the works superintendent and other non-technologists have a vitally important role to play even in a technical industry. In fact, to put it bluntly, the young graduates often need to have some corners knocked off when coming into industry. The second problem is that of the older and very successful research worker whose qualities demand that he should be kept on research work rather than being promoted to an administrative or executive post. The fact that status in industry and, with it, salary and privileges, usually depends on the number of subordinates one controls and the extent of one's administrative responsibility, tends to attract many ambitious young men out of purely scientific work into administrative work.

Very few industrial concerns have yet discovered how to give to the really brilliant research worker without any administrative responsibility an appropriate position. In this respect I think we might possibly learn from the armed forces who have divorced the question of rank from that of function. Thus in the Army, for example, when a man attains the rank of Colonel, whether he be sitting in a desk at a foreign embassy, acting as a staff officer in a ministry, or commanding a battalion in the field, he is entitled to the appropriate perquisites of his rank. This is a problem which many industrial concerns in Britain and America are considering, and one which will require much more careful thought in the future.

Staff Requirements.—There are three kinds of men needed for modern scientific work :

(1) Research pioneers. The real discoverers of new ideas are the spearhead of research, and every laboratory must include a sufficiently high proportion to be able to do any good at all. These men can be subdivided into three groups all essential in their own way ; the brilliant investigators who work best alone or with a few assistants, those who work well in a team and those with the ability to lead, inspire and coordinate a team.

(2) The research manager who is required to run a large research laboratory. Such men do not necessarily need great engineering skill or commercial acumen, but they do require a broad view of science combined with great personal qualities of tact and leadership. The principal requirements of the research manager are some intimate knowledge of at least one branch of science and the ability to select men, as I have already discussed, to organise and coordinate the highly specialised work of the laboratory, and to explain and interpret to the research staff and to the lay management each other's problems.

(3) The engineer organiser who can take charge of a project to convert an abstract scientific idea such as space travel, nuclear fission or radar to a commercial product. Such men must understand basic scientific ideas, have faith in their application, possess the engineering and managerial ability to bring them to reality and the economic sense to see their work in perspective and to control expenditure. Such men are extremely rare and there are too few in the world for the demands of the present day.

A major problem of management is to know how to produce these various kinds of men. If one looks at the brilliantly successful leaders of scientific research one is impressed by the variety of their background and training. Almost the only thing they have in common is that they have all been successful at individual research before becoming leaders and managers. This then may be the answer. We should look to the universities to produce first-class research workers, offer them comparable opportunities for first-class work in industry, and to those that show an aptitude for leadership give the chance to exercise responsibility. This method is more likely to produce the first-class men we need rather than attempts to devise courses in the management of research.

Utilisation of Staff.—A fundamental function of management is the proper utilisation of staff, but this is a matter which has received less attention in the scientific field than in the manufacturing field. Through the activities of your institutes and many similar bodies the application of work study, time and motion techniques and so forth, have led to enormous advances in productivity and efficient utilisation of shop floor labour. Comparable studies in the field of technical labour are remarkably few.

In my own company in recent years we have established a department devoted to analysing the work of graduate engineers in order to obtain a more efficient utilisation and with the steady increase in all countries of the ratio of technical staff to shop floor labour the importance of this work will grow.

The two most promising lines of investigation resulting from these studies concern the use of junior technicians and the use of computers to relieve highly qualified staff of routine work. So far this has been particularly successful in the field of design. The design of certain products, such as small transformers, which normally require the efforts of several senior men, can now largely be undertaken by computers operated by comparatively junior staff in a much shorter time. This leaves the really good men free for more advanced work especially the development of improved designs and techniques.

In a great many fields we are analysing the work done by our graduates to decide how much of it really involves their special training and abilities, and how much is merely the repeated application of techniques which can, in fact, be delegated to more junior staff. There are limitations in the use of these techniques. In the first place there is a danger of losing flexibility by delegating too much responsibility to too low a level, and in the second, it is at least arguable that graduate staff cannot be employed 100 per cent on highly original work but must be allowed to do a certain share of routine work, partly as a form of discipline and partly as a form of mental relaxation.

Nevertheless, within these limitations I believe there is enormous scope for the expansion of such work, and for its application to research laboratories.

It is interesting to note the great difference in the availability of assistance to research workers between different sorts of establishment and I have indicated some of these in Table III.

Table III—*Number of Technical Assistants Employed per Graduate Scientist in the United Kingdom*

Industry	3
Scientific civil service	1
Research associations	1·5–2
Universities	Less than 1

(Based on reports of the Advisory Council on Scientific Policy).

Generally speaking, in the universities where shoestring budgets are more common than in industry, there is a tendency to over-economise on junior labour. Although the discipline of having to do much of one's own routine work, including glass blowing and calculating results, is probably valuable for first-year graduate research workers, I am inclined to believe that in most universities this practice is overdone and that greater efficiency could be obtained by increasing the ratio of technical assistants to graduates.

Research Organisation in a Company

I have already mentioned that the greater part of research in industry is done by large companies because this is a most expensive activity to maintain. The way by which research is organised in various concerns varies considerably, and certainly in my own group of companies we have developed different approaches in different parts of the organisation over the years. This partly springs from the fact which I mentioned earlier that the most important consideration in research is the men available, and so the organisation tends to shape itself to the men available and to the work which is being undertaken.

Nevertheless, certain broad features emerge. The most satisfactory way to undertake this work in a large group of companies is that each product group of component company should undertake applied research in connection with its own products but that there should be one or more central laboratories dealing with fields of study applicable to a number of products :

for example, research into air flow has application to steam turbines, internal combustion engines, aircraft, guided weapons, aero engines, dam construction, air blast switchgear, cooling of large electrical machines, &c.

The principal objects of a company's central research laboratory should be: to produce sufficient new ideas to keep the company in the van of progress in its particular field; to maintain the company's prestige which is important both from the point of view of recruiting high-grade scientific staff and from the point of view of satisfying customers' technical staff; and to undertake on behalf of the product groups investigations that will eventually be of direct benefit to them.

One of the problems is to avoid unnecessary duplication between various parts of the group and yet to achieve co-ordination without wasting people's time sitting on committees and travelling around other laboratories. This is partly achieved through the method of budgeting which I described earlier, whereby inter-laboratory sponsored work is encouraged, and partly by an efficient system of abstracting and circulating reports. In addition the various research activities are co-ordinated by a representative research council immediately responsible to the Board.

Laboratory Organisation.—For the smaller company which is concerned with one or two research laboratories rather than several spread around the country there are various important problems to be tackled. Conditions vary so much from industry to industry and from company to company that it is impossible to lay down hard and fast rules for running research laboratories, but I would emphasise one particularly important feature and that is the importance of a well organised information service.

With the vast amount of scientific work going on in all parts of the world, and in view of the expense, not only in money but in the very scarce technical brainpower involved, it is essential to avoid waste and duplication and this in turn means that those concerned with research must be fully alive to what is going on elsewhere. In the case of a very small company thinking of employing perhaps two or three graduates in a research laboratory, they might find their money far better spent in keeping abreast of what other research laboratories are doing by employing somebody to study the technical literature and to maintain personal contacts with universities and Government research establishments. Most companies receive by every mail a great inflow of technical information through trade and technical journals, through sales leaflets and by other means, and it is very important that all of this should be properly sifted and circulated to those concerned.

I have said that such a service for a small company may be more useful than having its own research laboratory. Where a research laboratory does exist, proper facilities must be provided so that any research worker before tackling a new problem can acquaint himself adequately with what has already been done in this field through a proper library and abstracting organisation. Lay managements may often wonder whether expenditure on library information and abstracting services is fully justified, but in terms of efforts saved it represents a considerable economy. When we speak of a library in the context of research laboratories we do not mean a collection of text books so much as an organisation for the collection and sifting of technical information.

Another vitally important matter to be considered when establishing a research laboratory is the provision of adequate production facilities. There are two needs: first, the provision of small jigs and pieces of laboratory equipment and, secondly, experimental or pilot plant facilities for experiments related to actual manufacturing work. From the point of view of the laboratory obtaining things quickly with a minimum of fuss and from the point of view of production shops not wanting interference from the laboratories, it is essential that some facilities should be available under the direct control of the laboratories.

Where there are several research or experimental establishments involved it is often desirable to group them together so that certain common services can be supplied. The library and the workshops to which I have already referred come into this category and one might also include chemical and metallurgical laboratories for the carrying out of routine tests, analyses and other work which are not research in themselves but which are vital services to a research laboratory. In my own company we have a centre at Whetstone in Leicestershire where a number of quite unrelated laboratories have been established and we have been able to provide extensive common facilities of this sort which are far better than could be provided for each laboratory on its own.

Administrative Control.—Earlier I referred to the necessity of freeing research workers from administrative interference. This has been interpreted in different ways by different research organisations. It has sometimes been interpreted as meaning that within laboratories there should be built up a parallel organisation to handle administration and paper work but, in fact, this is of limited value. The senior technical official, from the director of research right down to the head of each team, must undertake responsibility for such matters as financial control and staff and although they may well benefit from the help of competent administrators who can deal with their paper work and undertake a great deal of routine administration on their behalf, this must not be carried to the point where the technical staff lose responsibility for these vital functions.

Conclusion

The main conclusion that can be drawn from this survey is that research is an integral part of modern industry. It is not an activity which can be regarded as so specialised that managers in other fields can ignore it. Talleyrand once remarked that "war was much too serious a thing to be left to military men," and it is equally true to say that research is too serious a matter to be left to the scientists. Managerial judgment and business acumen are vital qualities in the management of research and the leaders of Government and industry have to apply their minds as much to the problems of research as to any other subject.

Diesel Engineers Visit to Locomotive Works

On March 3 members of the Diesel Engineers and Users Association visited the works at Loughborough of the Brush Electrical Engineering Company, Ltd., where a programme of wide general interest began and ended with items drawing particular attention to the work of the company's Traction Division. The party's arrival at Loughborough Station coincided with the despatch from the adjacent sidings of the two most recently completed diesel-electric locomotives of the long series which the company is building for the Eastern Region of British Railways. Orders for these units announced to date total 155. Two are despatched from Loughborough at 12.30 p.m. every Thursday for acceptance trials at Doncaster, travelling coupled under their own power in charge of a British Railways driver and inspector.

The locomotives are of A1A-A1A wheel arrangement and in the British Railways Type 2 power classification. They are generally similar to the original batch of twenty described in our November 8, 1957, issue, page 683, but all since that series have been up-rated from 1250 h.p. to 1365 h.p., the speed of the Mirrlees JVS12T engine having been increased from 850 to 900 r.p.m. The Woodward governors are now adapted for air instead of solenoid operation, continuous engine speed control through a self-lapping valve having replaced the former individual speed steps in order to allow operation in multiple with other British Railways locomotives similarly controlled. The controller itself is now actuated by the usual form of horizontal lever instead of the vertical handle originally fitted, which had fore-and-aft motion for the two directions of running. Four notch positions are marked on the quadrant, and are definitely located by feel, to conform with settings at which control operations may be initiated in other locomotives of different design coupled in multiple. For example, in the Brush locomotives initial movement of the controller increases generator excitation through fixed resistance steps but in some others the engine speed is increased at an earlier stage. The control system supplies air for this purpose on the early step, and the various locomotive speed-setting devices are adjusted so that they respond at a particular pressure. One of the Brush locomotives has been delivered with its engine fitted with oil-cooled pistons and set to develop 1600 h.p. at 950 r.p.m.

These progressive increases in output from the Mirrlees engine have been achieved without recourse to intercooling and it would appear, therefore, that there is still scope for further up-rating. Simultaneously, developments being studied at Loughborough include the design of locomotives using Maybach engines manufactured by Bristol-Siddeley Engines, Ltd., another associate in the Hawker-Siddeley Group of Companies.

Two erection shops, one with a capacity for ten and the other for nine locomotives, are engaged on the present British Railways contracts at Loughborough and a new body shop has been built recently. A second resistance bank is to be installed for load tests of engine-generator sets. During their visit, the Diesel Engineers and Users Association party also inspected a 200 h.p. diesel-electric industrial shunting locomotive which has been supplied in considerable numbers for steel works, and had the opportunity to ride in the cab of one of the British Railways Type 2 locomotives on the company's test track. In the traction motor shop, machines for 25kV a.c. multiple-unit stock were seen under construction and it was noticed that these had laminations in the interpole magnetic circuit to improve commutation on rectified d.c.

A further item of railway interest seen at the works was a 25kV traction substation switchgear installation which had been assembled preparatory to despatch and erection on site for the Liverpool Street–Bishops Stortford electrification. This comprised low-oil-volume single-phase circuit breakers and two banks of interlocked manually-operated isolators arranged respectively above and behind the main switch units. The whole is mounted in a framework of which the rear wall and top enclosure will be formed by the wall and ceiling of the substation building. The rear access passage is within the switchgear supporting framework and has its own lighting to show the position of the isolators. Many examples of industrial machines and switchgear built at Loughborough were also inspected, including a large 11kV/440V cubicle board, with mimic diagram presentation of controls, for the B.B.C. Crystal Palace television studios, and the processes of manufacture and testing of transformers from 15kVA to 45MVA.

SHORTER REPORTS

Possible Sites for Coal-Fired Power Stations in Nottinghamshire

THE Central Electricity Generating Board states that suitable sites for large coal-fired power stations have been found at two places in Nottinghamshire : one is at Holme Pierrepont about 2 miles south-east of Nottingham and the other is at West Burton about 2 miles south-west of Gainsborough.

The search for sites has been concentrated near the Nottinghamshire and North Derbyshire coalfield, which is the largest producer of coal for electricity generation. Mining in this coalfield is extensively mechanised and a number of new sinkings or major reconstruction schemes are in hand. As a result the productivity of this coalfield, already well above the average for the country, is expected to rise still further, as is the output, particularly of the small coals that power stations can burn efficiently.

The West Burton site adjoins an existing railway line over which large quantities of coal can be drawn from collieries served by the network of railway lines in the northern part of the coalfield. The Holme Pierrepont site can be rail connected by a short spur off the line now being constructed to link the new Cotgrave Colliery with the railway system in the southern part of the coalfield. Each of the sites is considered suitable for a station of about 2000MW capacity, burning as much as 5,000,000 tons of coal a year ; and there is the possibility of further development at a later date. The sites are close to the River Trent, which is the only adequate source of cooling tower make-up water for large power stations in the East Midlands.

The investigations in the East Midlands have also revealed sites suitable for later power stations at Cottam and Ratcliffe-on-Soar, together with a site at Market Warsop that will become suitable if the dry cooling tower proves to be a commercial proposition.

Any stations that might be authorised to be built on these sites would incorporate large boiler and turbine units and would have the high efficiencies that are characteristic of stations now working or planned in the East Midlands, such as Drakelow "A," "B," "C" (2220MW), Willington "A" and "B" (800MW), Castle Donington (600MW), Staythorpe "A" and "B" (720MW) and High Marnham (1000MW). The association of advanced techniques of power generation with expanding coal production in the most highly mechanised coalfield is aimed at achieving the cheapest possible generation of electricity from coal, and it is the latest example of the forward planning that is helping to hold down power generation costs at the present time.

Results of the 1959 Road Census

THE Ministry of Transport has issued a brief statement on the results learned from last year's traffic census which was taken in August. The census showed that the number of motor vehicles counted was 12 per cent greater than in the corresponding week of 1958, and 56 per cent greater than in 1954, when the last comprehensive census was taken. Private cars showed an increase of 11 per cent and heavy goods vehicles 18 per cent over the one-year interval, but travel by bus and coach showed a slight decline.

The census was the fourth of an annual series, to estimate vehicle mileage on trunk and Class I roads and to enable traffic trends over these roads to be measured. Counts were taken at a hundred points from 6 a.m. to 10 p.m. each day during the week which ended on August 23, 1959. It was estimated that, during the week, some 810 million vehicle miles were travelled by all types of vehicles. Of this total, about 48 per cent was travel on urban roads ; 42 per cent of the total (340 million vehicle miles) was on trunk roads. Saturday was the busiest day of the week.

On the six weekdays, 62 per cent of the travel was by private car, with a higher proportion than this on rural roads and a lower proportion on urban roads, 12 per cent was made up of other passenger vehicles, e.g. buses, coaches and motor-cycles, and the remaining 26 per cent was goods traffic. On Sunday, however, 77 per cent of the total travel was by private car and 15 per cent by other passenger vehicles. Only 8 per cent was goods traffic. The largest percentage increase in travel over 1958 occurred in the Metropolitan Division (15 per cent) and the smallest in South-Western Division (6 per cent).

A similar census was taken at thirty-two points in Scotland by the Scottish Home Department in the same week. From this it was estimated that 108 million vehicle miles were travelled on trunk and Class I roads in Scotland during the week. The total estimated vehicle mileage on trunk and Class I roads in Great Britain was, thus, 918 million.

Lloyd's Register Annual Report

LLOYD'S REGISTER OF SHIPPING has issued its report for 1959, which opens with a reference to the celebration of the Bicentenary of the Society in May, 1960, and recalls its unique constitution in that there is no capital, no Articles of Association and no shareholders. Of the ships built to the Society's classification mention is made of several tankers of over 60,000 tons deadweight, and the Dutch liner "Rotterdam" as being completed, and of the liners "Oriana," "Windsor Castle," "Leonardo da Vinci" and "Aragon" as being fitted and afloat. The volume of plans submitted is reported as being 2,500,000 tons at June, 1959, compared with 5,000,000 tons in the previous twelve months. Reference is made to the carriage of liquefied gases and the success of "Methane Pioneer," and also to the building of the "Marwit" to carry liquefied chlorine in bulk at 325 lb per square inch and −40 deg. Fah. The "Dracone" flexible oil containers, it is stated, may now be submitted for classification.

The section of the report dealing with rules and regulations calls attention to new rules for oil tankers, in which formulæ replace tables of scantlings, and the completely revised Electrical Rules which are now under consideration. With the object of unifying standards for load-line assignment a conference was held at the head office in 1959, and the report expresses the hope that the results will assist the working of the International Loadline Revision Conference to be held in 1961. In the sector of marine engineering it is noted that diesel engines of 2000 b.h.p. per cylinder are available, so that these engines are now in competition with steam turbines for powering large tankers. However, steam conditions for turbine machinery remain largely unchanged at 850 deg. to 950 deg. Fah., although developments are in hand to use steam at 1050 deg. Fah. On the question of nuclear propulsion, it is stated that classification requirements are in the course of being formulated and that safety requirements are also receiving consideration.

The work of the land division on nuclear power projects, oil refineries and allied chemical plant and also conventional power stations is recorded in the report together with a note on metals production. The report continues with brief surveys of developments in many countries, a list of staff and members of committees, a short statement upon the state of shipbuilding throughout the world, and concludes with statistical tables and diagrams.

Fuel for Tokai Mura Nuclear Power Station, Japan

A DOCUMENT covering the heads of contract for the supply of natural uranium fuel elements for the nuclear power station being built near Tokai Mura, was signed in London on March 7 by Dr. Daigoro Yasukawa, president of the Japan Atomic Power Company, and Sir Roger Makins, chairman of the United Kingdom Atomic Energy Authority. This power station is being built by The General Electric Company, Ltd., of England, for the Japan Atomic Power Company, and it may be recalled that the contract for its construction was signed on December 22, 1959. It is a single-reactor station (graphite-moderated and gas-cooled) with an electrical output of 166MW.

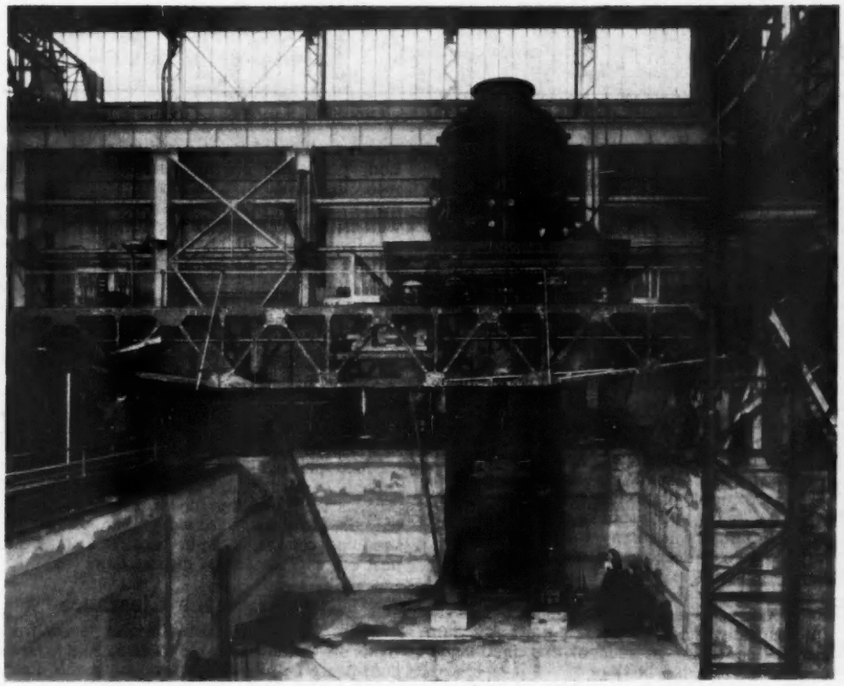
The document signed this week establishes the main characteristics of the subsequent detailed contract which will govern the supply of new fuel and the repurchase of irradiated fuel, for reprocessing, during the first ten years of operation of the reactor. This detailed contract is not expected to be signed until early in 1962, that is, about a year before the first deliveries of fuel will be required.

Incomes of Professional Men

THE table below shows the incomes in pounds sterling of people in a number of professions for 1955–56 at two ages, thirty-five to thirty-nine and forty-five to fifty-four, respectively. The figures have been abstracted from tables going into substantially more detail, contained in the report of the Royal Commission on Doctors' and Dentists' Remuneration. We comment upon the findings of that Commission on another page of this issue.

	Aged 35–39			Aged 45–54		
	Lower quartile	Median	Upper quartile	Lower quartile	Median	Upper quartile
Medical consultants*	2187	2463	2824	2995	3511	4501
Actuaries	1270	1656	2208	1822	2535	4080
G.P. doctors	1646	2116	2613	1900	2455	2935
Barristers	787	1306	2627	1159	2337	4944
Dentists	1851	2497	3332	1754	2302	3106
Solicitors†	1086	1393	2125	1607	2290	3561
Teachers (university)*	1100	1318	1700	1644	2016	2478
Chartered accountants	909	1250	1748	1299	1946	3000
Surveyors	959	1215	1800	1250	1891	3296
Engineers	965	1142	1376	1150	1484	2000
Architects	832	984	1263	930	1159	1543

* Ages 35–39 and 50–54. † England and Wales.



First reactor service machine vessel for Hunterston nuclear power station, supported from the ground before final installation in its bridge structure for tests at the Erith Engineering Works of the G.E.C.

Reactor Service Machine for Hunterston

THE pressure vessel for the first reactor service machine for Hunterston nuclear power station was installed recently on a bridge over a test pit at the G.E.C. Erith Engineering Works, to enable the internal mechanisms to be fitted and checked. A comprehensive series of tests of all operations of the machine is to be carried out at Erith before the machine is installed on reactor "A" at Hunterston.

It will be recalled that each of the two Hunterston reactors will use a charge machine operating from below the reactor, leaving the area of the top shield free for maintenance operations to be carried out by the service machine. This machine is capable of performing all normal reactor maintenance duties, together with a number of emergency operations; with few exceptions, these operations can be carried out with the reactor under pressure and on load.

The machine consists essentially of six specialised handling units contained in a pressure vessel, which is mounted on a movable bridge with longitudinal and cross travel, so that it can be positioned over any one of the 208 standpipes connecting with the reactor. Two identical handling units are used for control rod and motor replacement, another pair are used for removal of distance tubes and control rods in the event of cable breakage, one carries a set of telescopic tubes for the insertion of thermocoupled fuel elements, and the sixth has telescopic tubes to link with any fuel channel for more general purposes, such as the insertion of a television camera.

The pressure vessel takes the form of a stepped cylinder, 44ft (13,400mm) long and 11ft (3350mm) in diameter at its larger end and weighs 34½ tons. It is supported on its bridge by screw jacks, and hydraulic jacks enable its vertical position to be adjusted.

A test pit was specially made in one of the workshops at Erith, and the bridge assembled over one end as illustrated. To install the pressure vessel in the bridge, the two shop overhead cranes were used to lift it with its axis horizontal, then to lower the bottom end until the vessel was vertical, and finally to place it into position within its jacking frame. Here it was supported from the ground pending the installation of the fourth side of the frame and commissioning of the jacking system.

Construction and testing of this service machine will form the first of a series of such projects, the test pit and its associated structures having been designed to accommodate two of the three Hunterston charge machines and one of the two service machines at the same time.

The pressure vessel for the service machine was fabricated by The Motherwell Bridge and Engineering Company, Ltd., and final machining was carried out by G. A. Harvey and Co. (London), Ltd.

Hunterston nuclear power station is being built for the South of Scotland Electricity Board, by The General Electric Company, Ltd., of England, a member of the G.E.C.-Simon-Carves Atomic Energy Group.

Car Park Space Saving

A MECHANICAL system of car parking which greatly reduces the area needed for access lanes, called "Carpack," was this week demonstrated on its initial installation in Bow Bells House in the City of London. The system is claimed by its sponsors, Economical Parking, Ltd., 11, Kensington Church Street, Kensington, London, W.11, to allow an increase of the order of one-third in the number of vehicles that can be stowed in a suitably shaped space.

If it is considered that cars be parked in ranks side by side, then if it is required to have access to any car without moving any other car on its own wheels, each rank must have an access lane either in front of or behind it. The new system over-rides this limitation by introducing a method of moving the vehicles (sideways) along a rank; thus if there is left one space in a rank, that space can be presented to the car which needs to cross the rank. In the installation illustrated there are no more than two ranks each side of the access lane, and only that nearer the lane need be mechanised. However, a more ambitious scheme now in preparation for installation in Switzerland uses several ranks with a lane behind the rearmost and in front of the foremost, so that cars will drive forward both into and out of the matrix. In general, only one car at a time can be moved into or out of store.

The construction of the "Carpack" can be followed in our illustration. Each car in a rank that has to be crossed by other cars is parked on a platform provided with guides for the car wheels, which can move sideways on two tracks and a guide rail. The end platform is connected to a steel cable which is driven by an electric motor, and between all the platforms are automatic couplings (these consist of hooks on Andre-Neidhart pivots which both provide spring action and eliminate wear). To gain access to a particular car or platform the platforms are first closed together by moving the driven platform away from its end of the rank. The couplings on the appropriate side of the space it is desired to clear are then opened by treading on raised levers, and the driven platform is moved back to its own end, pulling with it the platforms as far as the open coupling. It is arranged that warning barriers must be pulled down before the drive system can be energised, while movement stops as soon as the control knob is released. The driving motors need not be in the same enclosure as the cars, so that fireproofing is not difficult. The present installation is unattended, but in a public park it would presumably be necessary to provide supervision to prevent parking in the spaces between platforms, or one person moving platforms while another was trying to drive between them. In an attended park it is reasonable to have several ranks of platforms as indicated above, and it is proposed to develop some technique of remotely or automatically opening couplings to save the time taken walking through the stack to work couplings.

[Reply Card No. E4372]

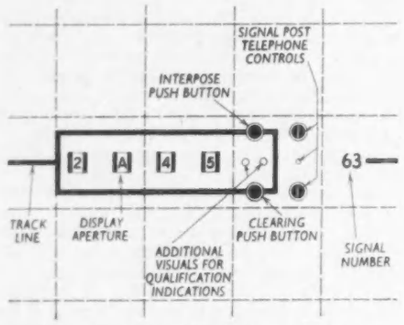
"Carpack" mechanical car parking. Separate platforms for each car run on tracks and a guide rail

SHORTER REPORTS *(Continued)*

Train Describer Developments

THE increasingly large areas controlled from present-day power signalboxes, and the replacement of intermediate boxes by automatic signalling, have made it necessary to reconsider the conventional forms of train describer display. In general, describers have shown the signalman the descriptions of the first, second and third trains approaching his area, and these descriptions have been sent forward to the next box as the trains leave his control. It now seems desirable not only to show the descriptions of approaching trains in some detail, adapting the display capacity to operational requirements, but also to record the passage of trains through the area controlled from a box by exhibiting the descriptions at appropriate points on the track diagram as each train progresses.

A description of the methods being adopted for the above purposes in the Western Region of British Railways was given in a paper presented to the Institution of Railway Signal Engineers in London on March 2 by Mr. M. E. Leach, Assistant Signal Engineer. He explained that the form of display was that of the British Transport Commission's four-digit train description scheme, consisting of a numeral, a letter, and two numerals (as seen in the diagram reproduced from the paper). The first digit was related to the existing head lamp and block bell codes (denoting class of train) ; the letter in the second position identified destination area or district ; while the third and fourth figures were the individual train number.



Basic form of train describer display now being used on British Railways, Western Region

The Western Region had adopted as standard for major signalling schemes a miniature control panel combining the track diagram and operating console. While it was desirable to show the train descriptions on this panel, it might not be practicable to do so with the miniature display equipment available, and the present method was to divorce the describers from the control panel proper and to employ instead a separate display field located at eye level on a ledge at the rear of the control panel. This arrangement as applied at Birmingham (Snow Hill) signalbox was illustrated in the paper.

The describer display panel carried a track line diagram of the main running routes, and at each running signal position a miniature four-character illuminated display unit was fitted. Push-buttons for interposing and clearing displays were adjacent to the unit ; also two lamps for qualifying descriptions (as for denoting attachment of a banking engine), and the telephone call lamp and answer push-buttons associated with the signal to which the display applied.

In the Western Region describer a standard telephone dial was used for set-up purposes, the required figure/letter combination being dialled as in automatic telephone practice. Stepping of descriptions from one display to another in sympathy with the movement of trains was usually initiated when the track circuit immediately ahead of the controlling signal was occupied, the interconnection of the display units during stepping being established from the appropriate route relay circuits.

Where permissive working was authorised, several display units (according to the number of trains normally acceptable) were displayed in series on the track line. If, in exceptional circumstances, an additional train was admitted to the section, the description in the last of the series of units began flashing and an audible signal sounded as a warning that it was about to be displaced. The signalman thus had time to note the description before it was cleared prior to the incoming description taking its place. A warning light then reminded him that a description had been " lost," and that he must set it up and interpose it again when display capacity became available.

Forward transmission of descriptions from box to box took place automatically in appropriate conditions, but could be effected manually by push-button when early warning was necessary to avoid delay. " Train approaching " display units were placed on the diagrams in positions offset from the track lines, and the descriptions displayed there stepped forward automatically into the track line units as a train passed the signal in rear of the first signal controlled from the box.

After discussing various methods of displaying information in a scheme such as this, some of which enabled information to be amplified by means of coloured backgrounds to the characters, Mr. Leach described the system forming the basis of the Western Region describer itself. This made use in each display position of four individual high-speed electro-mechanical counter units, assigned to the four decades of the train recognition code. Each of these counters had a single register drum. When it was desired to display a description, all four drums were independently but simultaneously revolved from their " home " positions by extending to their driving coils trains of the appropriate number of impulses from the telephone dial. The characters located behind the viewing apertures were invisible until the drums were internally illuminated by small lamps contained in each unit.

It was possible with the system described to detect predetermined train movements by comparing their descriptions against preset code combinations stored in the train describer. An example of this would occur at Old Oak Common, where all trains which were routed over the facing junction to the Northern (Birkenhead) line would raise an audible alarm to draw the operator's attention to their approach. This would apply when the junctions were set for the main (Reading and West of England) line, with automatic working of signals in force.

A further possible development was an automatic recording equipment to take the place of the train register book. The passage of a train past a nominated point could cause its description, previously set up automatically in the recording device by a slave feed from the main describer, to be printed on a paper roll, together with its time of passage. A number of sets of such equipment could be located in a central control office, and information derived from these sources could also be made available to station announcers and for the operation of train arrival indicators.

Exhibition of Car Parking

THE British Road Federation is to hold an exhibition of car parking at the Institution of Civil Engineers, London, from March 18 to 26. It will consist of a comprehensive collection of models, photographs, drawings and plans of garages of all kinds. Schemes and completed projects from all over the world are to be displayed. Motorway service areas, " motels," shopping centres, drive-in banks, cinemas and post offices will also be displayed.

Snow and Ice Clearance

MECHANICAL methods of clearing snow from roads are usually not able to displace a layer of hard-packed snow or ice, and have the disadvantage that they usually require heavy and expensive plant which is difficult to justify for low utilisations. To avoid these difficulties there has been evolved by Mobile Jet Dispersals, Ltd., 2-26, Benwell Lane, Newcastle upon Tyne, an appliance for thermal dispersion of snow and ice ; the running costs of such a device burning gas oil are naturally relatively high, but the equipment needs only a Land-Rover to carry it and the heating head can be removed from the front of the vehicle when freezing weather is not expected. The vehicle carries an oil pump and an air compressor supplying a set of " Swirlamiser " burners in the heating head, each burner being controllable from 40,000 to 120,000 B.Th.U. per hour. Secondary air is supplied by a fan through three 6in hoses, visible in our illustration. The heating head is moved up and down by a single hydraulic ram and protected from contact with the road by castors.

The " Snow Locust " would tend to leave the road under it wet, which would obviously be dangerous in freezing conditions. It is therefore provided with a squeegee and a rotary brush which leave the surface merely damp, provided the road is drained. Additionally, a spreader of sand, salt or grit can be attached.

Two models are available, the " Town " and " Country," able to enter drifts 3ft and 7ft deep respectively. The heat rate is claimed to be adequate to cut a 9ft path through 6in of snow at 4 m.p.h.

[Reply Card No. E4383]

The " Snow Locust," a machine which melts and disperses ice and snowdrifts

Concrete-Framed Building to Resist Mining Subsidence

THE accompanying drawings show in outline the structural frame and substructure of the college of further education at Ystrad Mynach, near Cardiff, which has just been completed for Glamorgan County Council. The design allows for the possibility of mining subsidence ; should subsidence occur, the building can be levelled by jacking. There are two buildings at present. One is a two-storey workshop block and the other is a four-storey block with classrooms, laboratories and offices.

The four-storey block is 136ft long and 60ft 8in wide ; it consists of two buildings which are entirely separated by a 3in wide structural break, with the classroom buildings, 60ft long, to the west of the break and the administration building, 76ft long, to the east. Each floor is carried on a central spine which consists of two rows of *in situ* reinforced concrete columns. The columns are supported, in turn, by a prestressed concrete foundation beam of box section which rests on two mass concrete piers (this arrangement is, of course, duplicated on each side of the break).

Two points of support were provided at each pier and the building can be jacked should any settlement of these mass concrete piers take place. The bearings at the piers consist of built-up steel assemblies cast respectively into the concrete of the box beam and the pier, thus leaving exposed flat bearing plates between each pair of which is a shim. On each side of these bearings, pockets have been left where jacks can be inserted if necessary. Should it prove necessary to raise the building, sufficient 100-ton jacks would be positioned in these pockets and then the end of the box beam raised by them, and further shims inserted at the bearings to level the box beam. "Draw" (i.e. horizontal movement) at the bearing can be accommodated by sliding at the shims. The maximum differential settlement which will be tolerated between one pier of the main building and any of the three others before the building is jacked is 1in. This limit is imposed to prevent any possibility of damage at the structural break.

Each pair of columns carries, at each floor level, a precast concrete truss 60ft 8in long, which cantilevers out beyond the columns. The overall depth of the truss at the columns is 4ft 1in, tapering to 7½in at the extremities. The top chord member was cast and prestressed with "Macalloy" bars before the remainder of the truss was cast.

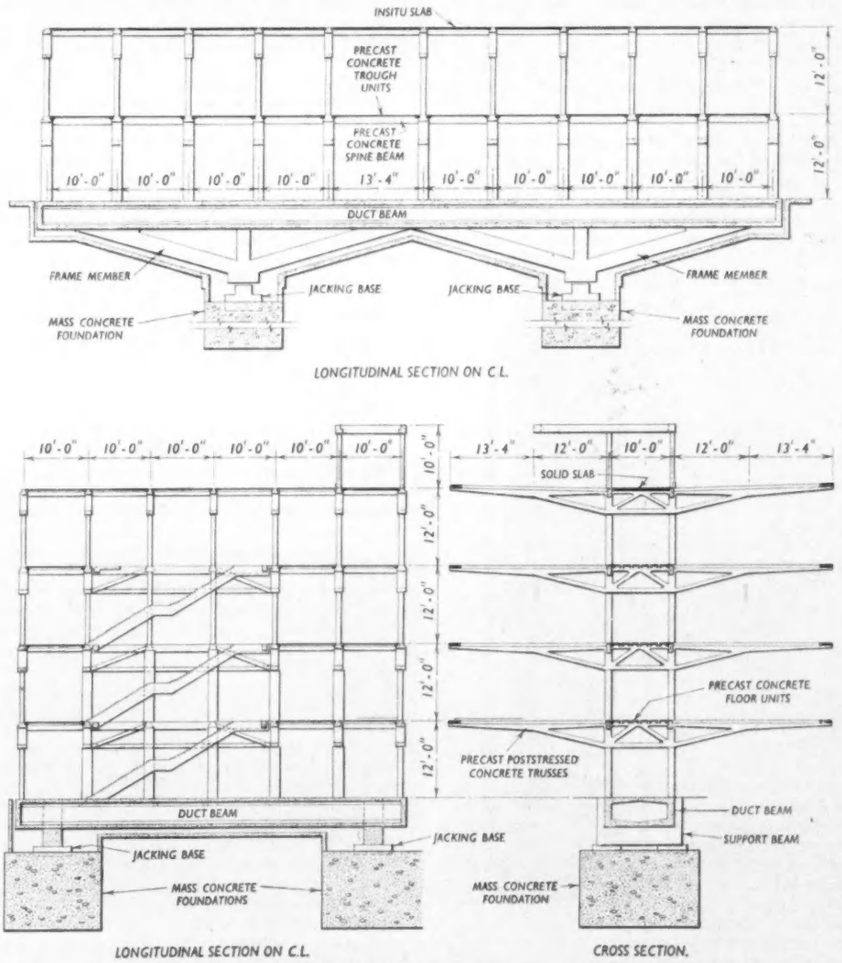
In both blocks there is a staircase within the spine structure. In order to cater for these stairs, the centre portion of certain trusses has had to be omitted. Where this occurred, an *in situ* prestressed and reinforced concrete-latticed construction was formed between the half-trusses and the adjacent full truss. This latticed construction consists of prestressed concrete diagonal members in the plane of the floors and reinforced concrete diagonal members in the plane of the lower, inclined, members of the trusses. At the lower end of the inclined member there is an *in situ* prestressed beam which runs along the side of the columns. Working stresses in the main structure were as would normally be expected in this class of structure, and no reduction was made because of the possibility of jacking.

Building construction throughout was kept as light as possible. Services were accommodated within the box beams and the floor trusses. The external cladding of the building is mainly aluminium curtain walling and aluminium sheeting ; thermal insulation is internal.

The workshop block is 103ft long by 60ft 8in wide. Its superstructure is similar to that of the classroom and administration block, with the exception that precast concrete trough flooring was used for the first floor. In this case the spine columns are supported on concrete foundation trusses, as shown in the drawing. The duct beam is prestressed by the Freyssinet system, and there are four jacking bases, at each of which two 100-ton jacks may be positioned.

The consulting engineers for the structural work at Ystrad Mynach college were Felix J. Samuely and Partners, and the main contractor was William Moss and Sons, Ltd. The architects were T. Alwyn Lloyd and Gordon.

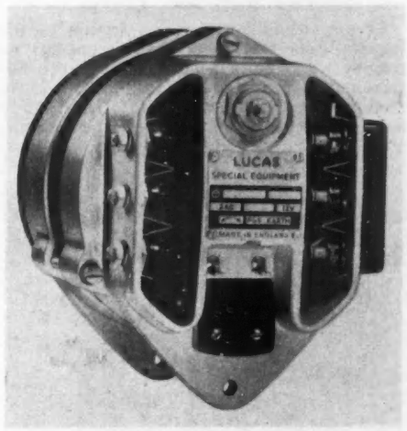
[Reply Card No. E4391]



Structural frame and substructure of the college of further education at Ystrad Mynach. The upper view shows the workshop block, and the lower views the main block

A.C. Generator for Motor Vehicles

FOR motor vehicles equipped with two-way radio and other electrical apparatus imposing unusually high electrical loads, Joseph Lucas, Ltd., Great King Street, Birmingham, 19, has developed an alternating current generator, model 2AC, and an associated output control unit, model 2TR. This a.c. generator is considerably lighter than a d.c. generator of equivalent output. Specifically, the 2AC generator gives a nominal output of 45A at 13·5V, with a maximum speed of 11,000 r.p.m., is 6in in diameter, 5¾in long and weighs 17¼ lb without its cooling fan (18¼ lb with fan). By comparison a conventional d.c. generator, with a maximum output of 35A at 13·5V and a maximum speed of 9000 r.p.m., is about 8in long, has a yoke diameter of 4·8in and weighs 26½ lb, excluding the fan.



Alternating current generator (Lucas type 2AC) for motor vehicles with unusually heavy electrical loads. This view shows the silicon diode rectifiers mounted in the end bracket of the generator

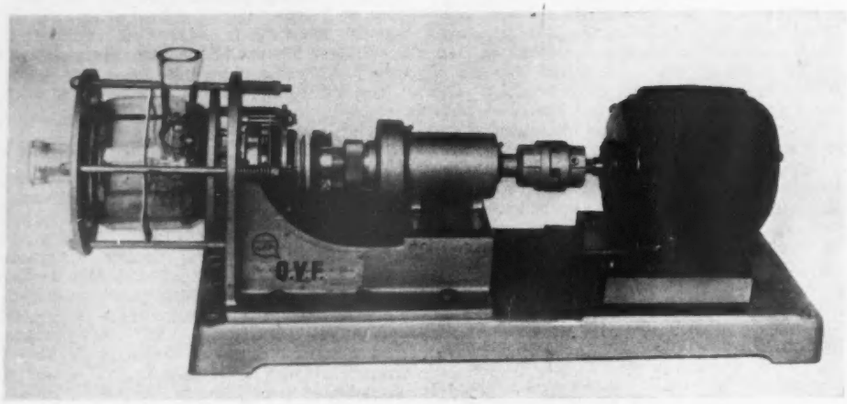
The main advantage of the a.c. generator, which becomes significant at outputs such as those quoted above, springs from the elimination of the commutator. First, there is a direct saving in weight and overall length ; secondly, without a commutator higher speeds are permissible, and therefore a correspondingly higher output can be obtained from a given size of machine ; in addition, because of the higher speed, the driving pulley ratio can be high enough to give a useful output at low road speeds.

The 2AC alternator has a stator output winding and a revolving field which takes its excitation, through a pair of sliprings, from the stator winding. Lucas silicon diode rectifiers convert the alternating current output of the machine to direct current. As illustrated here, these silicon diodes are built into the end bracket of the generator where they are in the path of the cooling air drawn into the machine by a 6in diameter fan.

A transistor-assisted regulator in the associated 2TR control box maintains the alternator voltage between preset limits. No external current-limiting device is needed to control the output since the reactance of the alternator is sufficient to limit the current to 60A–65A (cold) and 52A–57A (hot) at rotor speeds up to 11,000 r.p.m. A reverse-current relay is not needed, since the rectifier diodes prevent flow of reverse currents.

[Reply Card No. E4392]

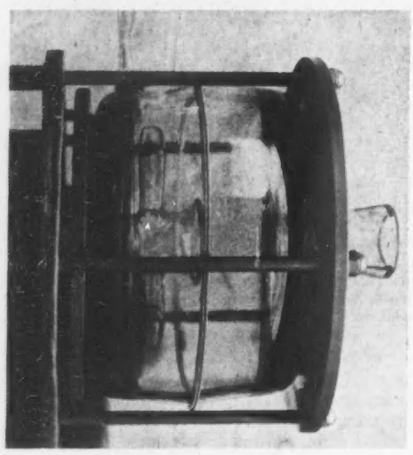
SHORTER REPORTS *(Continued)*



Motor-driven centrifugal all-glass pump

Two All-Glass Pumps

IN the chemical engineering section of the Imperial College of Science and Technology we recently witnessed a demonstration of two all-glass pumps produced by Q.V.F., Ltd., Duke Street, Fenton, Stoke-on-Trent. These pumps are the outcome of some two years' endeavour, spent on design and development work, to produce a pump for handling corrosive liquids of a consistency similar to water. Two models are now in production, marks G.P.A./6 and G.P.A./9, the former driven by a 1 h.p. motor and the latter by a 3 h.p. motor, both being four-pole, three-phase units. The respective performances of the two pumps when pumping cold water are as follows.



Glass impeller

	G.P.A./6			G.P.A./9			
Gallons per minute	10	30	50	20	40	60	100
Total head, feet	24	20	13	45	41	35	25

Both pumps are of centrifugal pattern running at a medium speed of 1440 r.p.m., and the glass impeller, seen in our illustration, is of simple design based on a vortex pattern inlet, having four specially designed arms. The mechanical seal is a glass-loaded "Fluon" bellows rotating against a glass plate and the precision ground hollow glass impeller shaft, which is sealed off from the impeller, is held in an aluminium alloy chuck and steady bearing by means of a brass compression cap and four rubber "O" rings separated by brass sleeves.

Both units require priming and both are mounted on heavy cast iron base plates, as can be seen in the photograph which we reproduce of one of the pumps. The net weight of G.P.A/6 is 225 lb and that of G.P.A/9 is 267 lb.

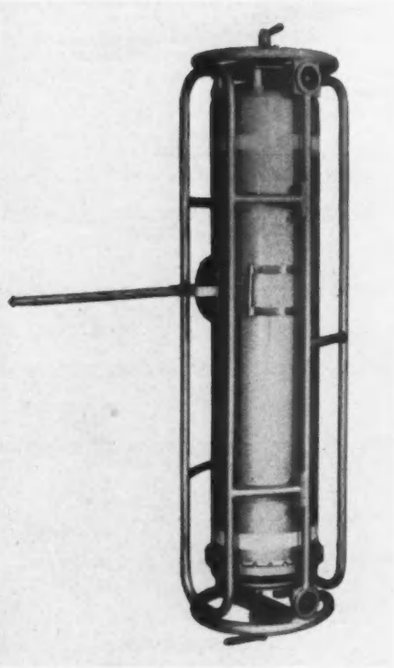
[Reply Card No. E4401]

Portable X-Ray Unit

A LIGHTWEIGHT, portable industrial X-ray equipment of 300kV capacity, has been introduced by Pantak, Ltd., Vale Road, Windsor, Berks, for examination of mild steel of up to 3in thickness. In this equipment, illustrated herewith, both insulation and cooling of the tube is effected by an inert, non-inflammable gas. The use of this cooling medium results in a lightweight tank head construction and achieves a high power/weight ratio, the equipment having a weight of only 142 lb and a capacity of 300kV. The set can be supplied with either a conventional 40 deg. solid angle beam insert tube with a fine focus, size 3·0mm, or a 360 deg. circumferential radiation insert tube. In each case cooling of the anode is by forced circulation of the insulating gas by an internal blower.

The pressurised tank head is cylindrical, and the tube is protected against excessive temperature by a thermal switch mounted in the tank head. A device in the control unit simulates the thermal capacity of the anode and gives the operator a visual indication of overheating. The equipment control operates from a 220V, 50 cycles, single-phase, supply and accommodates fluctuations of 10 per cent either way. It is fitted with direct reading kilovolt and milliameters in addition to a synchronous timer which can be arranged for automatic repetition of exposures. The stepless kilovoltage and tube current controls permit continuously variable control.

[Reply Card No. E4402]



Gas cooled 300kV portable X-ray equipment

Improvements at Grangemouth Docks

A MAJOR scheme of improvement is to be undertaken by British Transport Docks at Grange Dock, Grangemouth, at an estimated cost of £1,700,000. Grange Dock, constructed in 1906, has a water area of 30 acres and is the largest of the four docks at the port. It is connected with the River Forth by a water channel and an entrance lock, 626ft in length and 80ft in width, through which vessels drawing up to 25ft 6in are able to enter and leave on all tides. Within the last year or two, considerable improvements have been effected at the North and East Quays. The present scheme, which will complete the modernisation, will improve the South Quay and the north and south sides of "The Tongue," a projection 250ft in width and 1200ft in length at the western end of the dock.

On the Tongue two existing transit sheds will be supplemented by two new single-storey sheds, 400ft and 500ft in length respectively, and 60ft wide. Fourteen level-luffing electric cranes with a radius of 65ft will be installed so that each of the quays will be equipped with six 6/3-ton and one 10/3-ton cranes. The crane tracks will be renewed, the railway layout modernised and the quay resurfaced in concrete.

The South Quay is now used partly for loading coal and partly for general cargo. Severe reduction in coal shipments has made it possible to remove the four coal hoists and to concentrate the remaining traffic in another dock at the port. The section of the quay available for general cargo will be extended from 1200ft to 1800ft and on this length, crane and railway tracks will be renewed, the quay surface repaved in concrete and eight new level-luffing electric cranes installed, each with an out-reach of 65ft—four of 6/3-ton and four of 7½/4 tons. In addition, two electric cranes of 3 tons capacity will be transferred from another part of the dock.

It is hoped to complete the whole scheme within two years.

Electrical Storage Tube

WE have received particulars from the English Electric Valve Company, Ltd., Chelmsford, Essex, of a new storage tube, E704, a device in the "Nesotron" or "island storage" category. Two separate electron guns are used for writing and reading information on the target, which consists of an array of about 2000 gold strips deposited on a thin glass plate which is backed by a continuous metallic film forming the signal output electrode. Information supplied to the writing beam is stored as negative charges on the metallic strips. One application is to extend the range of radar systems by using the storage property to improve signal-to-noise ratio, a number of writing scans—ten, for example—being made for each reading scan. In the reading scan, all negative charges are neutralised by the reading beam, thereby erasing the stored information. Writing and reading may be simultaneous or consecutive, but in the former case it is necessary to modulate the reading beam in order to separate the writing and reading signals, which both appear in the output circuit as capacitive charging currents. The tube also has analogue and digital storage applications, with a storage capacity of about 500 bits.

[Reply Card No. E4404]

Factory Floor Cleaning Machines

Two machines have been developed by the British Vacuum Cleaner and Engineering Company, Ltd., Leatherhead, Surrey, for breaking up and removing deposits of impacted grease and dirt from factory floors. The first of these machines, known as the "Hedgehog," is a dry scrubber and scarifier, and the second an industrial vacuum cleaner incorporating a cyclone separator instead of the usual filter bag —which would be pierced and damaged by metal swarf and filings if fitted.

The "Hedgehog," to be seen in use in one of our illustrations, has on its underside a group

Battery-driven machine removing compacted grease and dirt from a factory floor

of rotating wire brushes which cover a width of 19in and can be raised or lowered in their support frame or set at an angle to comply with the depth of deposit to be removed. According to the duty, brushes of heavy or light gauge spring steel wire can be fitted and they are designed to intermesh during operation to cover completely the working width and granulate compacted dirt on a floor. The machine has a cast aluminium frame in which a ¾ h.p. battery-powered motor drives the brush spindles through "Tufnol" gears at about 350 r.p.m. A rotary reversing switch used to reverse the direction of brush rotation is stated to lengthen the effective life of the brush bristles, wear of which is usually increased by rotation in one direction only.

The tubular steel handle of the machine carries the control switch and is coupled to the axle of two 5in wheels; the brush height screw adjuster is also mounted in an accessible position on the the handle column. In addition to the rear mounted batteries a water tank can be mounted on the machine to convert it for heavy duty wet scrubbing. The complete battery-driven machine weighs some 360 lb, but the assistance given by the rotation of the brushes enables it to be moved with relative ease along the floor. This machine is also available with a capacitor start 1 h.p. motor drive for a.c. mains operation through a trailing cable, and in this form its weight is 140 lb.

Vacuum cleaning machine with cyclone separator top for handling swarf and solids likely to damage a filter bag

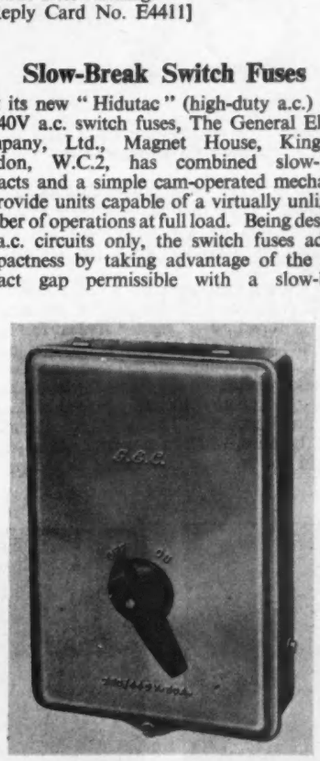
The portable vacuum cleaner adapted for operation in conjunction with a "Hedgehog" machine can be seen in our second illustration. The four-stage fan of this machine is driven by a 1 h.p. motor at 6600 to 8200 r.p.m., giving a closed vacuum reading of about 65in water gauge and with a 1½in hose a volume of 109 cubic feet per minute at the nozzle. The machine shown is fitted with a 20in wide suction nozzle which is coupled by a 2in flexible hose to the cyclone top of the main chamber. A swirling motion is imparted to the dirt-laden air entering the cyclone top and the dirt gravitates into a bucket of 1 cubic foot capacity in the bottom of the chamber.

The machine can be used with a 7 square foot area filter bag and the cyclone top and bucket adapt it for double filtration duties such as when removing flour, powder or soot on cement floors and other filter choking or filter passing materials. The cyclone and dust bucket also make it suitable for dealing with heavier materials such as small nuts, nails, pieces of metal, glass swarf, &c., which might damage the filter bag. The cyclone head can also be fitted with a shut-off ball valve to enable the machine to be used for sump emptying, or for picking up water from the floor after washing.

[Reply Card No. E4411]

Slow-Break Switch Fuses

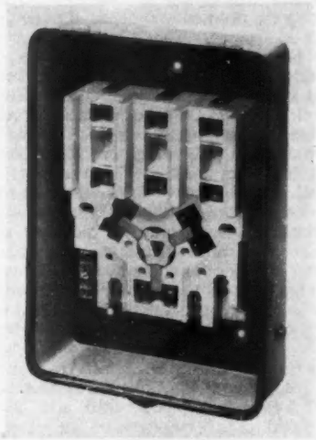
In its new "Hidutac" (high-duty a.c.) range of 440V a.c. switch fuses, The General Electric Company, Ltd., Magnet House, Kingsway, London, W.C.2, has combined slow-break contacts and a simple cam-operated mechanism to provide units capable of a virtually unlimited number of operations at full load. Being designed for a.c. circuits only, the switch fuses achieve compactness by taking advantage of the small contact gap permissible with a slow-break



Switch fuse with cam-operated contacts controlled by rotary handle

action, the arc being extinguished by the passage of the current through zero while the contacts are separating. The operating handle seen in the illustration above has a rotary action and engages with the cam shown in the other view of a switch interior with the protective covers removed. The cam operates the spring-loaded contact elements through push-rods. Cam and push-rods are of "Steatite," and the contacts are solid silver. The illustration shows the individual enclosure of the switch elements for separate phases and the two breaks of each element. In this view the switch cover and the terminal screens have been removed. The screens, inscribed "live terminals," can be swung clear for access to the terminals by slackening the single-screw fixings. A normal interlock is provided to prevent opening of the front cover unless the switch is "off."

Type tests have shown that the units are in good working order after 100,000 mechanical



Interior of switch fuse with covers removed to show switch elements and cam

operations, and after 50,000 operations at 50 per cent overload controlling a tungsten lamp load, when there were no signs of contact welding due to the high inrush current. The switches will also break repeatedly full-load current at maximum rated horsepower of 440V squirrel cage motors with direct-to-line starting. They are also suitable for transformer switching and the group control of blocks of lighting, either tungsten or fluorescent, in large industrial and commercial installations. Switch mechanism and fuse bases are moulded in single-piece porcelain units, which are enclosed in deep-drawn steel cases, fitted with P.V.C. gaskets. The front-operated rotary handle is moulded in toughened polystyrene. Initially the switch fuses are available in 15A, 30A and 60A ratings, single-pole and neutral, double-pole, three-pole, or three-pole and neutral, with h.r.c. or semi-enclosed rewirable fuses.

[Reply Card No. E4412]

Midland Motorway Links

The Minister of Transport has published the proposed line of a further 16½-mile length of motorway in the Midlands, extending from the present northern terminus of the proposed Bristol-Birmingham Motorway, just north of Lydiate Ash, to join the proposed Coleshill-Dunston section of the Birmingham-Lancaster Motorway, just south of Walsall. It is proposed that the new motorway link should run from Lydiate Ash northwards, to enter the Birmingham conurbation near Quinton. A feature of the road would be a 3-mile long viaduct over the Western Region railway, to the south of West Bromwich. This unusual proposal was illustrated in The Engineer of October 24, 1958, when the idea was first announced by the Ministry of Transport. From West Bromwich to the junction with the proposed Coleshill-Dunston Motorway, south of Walsall, the route is substantially the same as that previously advertised in the original draft scheme for the Birmingham-Preston Motorway. The terminal junction near Walsall, it is proposed, should be triangular in shape, so that traffic from the south-west could proceed either northwards to the Black Country or Lancashire or eastwards to Birmingham without reducing speed. Access to the new road would be restricted to a limited number of two-level junctions with main roads crossing the route, proposals for which will be advertised at a later stage, the Ministry states.

SHORTER REPORTS *(Continued)*

Electronic Pipe Finder

MANUFACTURE has begun in this country of the "M-Scope" pipe finder shown in the illustration below, a device which has been used extensively in North America for detecting the position and depth of underground cables and pipes. The "M-Scope" is being made here by Bruce Peebles and Co., Ltd., Edinburgh, 5, from whom we have received details of its operation and construction. It consists basically of a transmitter and a receiver unit, each incorporating a loop aerial. As illustrated, the two units are assembled for search or survey duties. The transmitter is at the rear and the receiver in front, arranged with their loops at right angles so that, with no disturbing influence present, the user should not hear the transmitter signal (a modulated tone) in headphones connected to the receiver. When the finder is moved over a metal object, a signal is picked up because of reflection of the transmitter output, and is maximum when the receiver is directly over the object. Various effects may arise from other reflections but are easily recognised by an experienced operator.

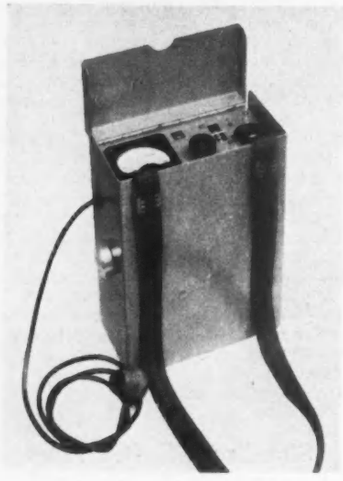
To trace a line of pipe or cable after location, the transmitter may be placed on the ground and connected directly to it. The receiver is carried in the hand, the operator directing his steps so that maximum signal is heard in the headphones. In using this method the accuracy is stated to be of the order of 1ft, depending on the depth of the pipe and distance from the transmitter. For more accurate location the transmitter may be laid flat on the ground over the pipe, and with this disposition of its loop a position of no signal in the receiver is found directly over the pipe. Accuracy using this method is of the order of the radius of the pipe. The transmitter will radiate a 800 c/s tone or will pulse-modulate it at two pulses per second. Modulation of the tone assists discrimination between several services running close together.

The receiver incorporates a two-way spirit level indicator for use in depth measurement, for which various procedures are used, but all depend on angle of tilt. Both transmitter and receiver are transistorised and incorporate printed circuits. The cases are of "Fibreglass." Power consumptions are 15mA and 40ma respectively from a 9V dry battery. The weight of the complete equipment as illustrated is 10 lb. A modified receiver with additional four-stage amplifier, a crystal pick-up and sounding accessories is supplied when the apparatus is to be used also as a leak detector.

[Reply Card No. E4421]

Non-Ferrous Metal Classifier

VARIATION in the characteristics of an oscillatory circuit according to the conductivity of metal specimens presented to the sensing head is the operating principle of the "Sortationer" for non-ferrous metals made by Townson and Mercer, Ltd., Beddington Lane, Croydon. The user sets up the instrument by means of an aluminium, copper or magnesium standard, adjusting the controls so that the meter, seen in the accompanying illustration, reads to a reference



Portable alloy classification device based on a conductivity-sensing circuit

mark on its scale. Alloys of these materials are recognised by the readings obtained when they are substituted for the standard. The dial is calibrated in arbitrary units for comparative purposes only.

The sensing head contains a coil connected in the grid circuit of a valve oscillator, the anode of which is tuned to a slightly higher frequency. When the sensing head coil is brought near a sample, its inductance is reduced and the grid and anode circuits of the oscillator tend to come into tune, thereby increasing feed-back until oscillation occurs. The reduced inductance occurs because, when in proximity to a sample, the grid coil may be considered as the primary of a transformer, the secondary of which (the sample) acts in the manner of a single-turn shorted secondary. The losses in the grid coil are also increased in these conditions, and the maker states that, by taking advantage of both phenomena, the sensing head has been made relatively insensitive to distance from the sample under test. This patented feature is claimed to give a constant reading even if the head is not kept quite square on the surface, or if the surface is uneven, anodised or painted. Other suggested applications are to determine which is the clad side of aluminium-coated sheet, or to serve as a "go, no go" gauge in heat-treating processes. The weight of the instrument with batteries is 6½ lb.

[Reply Card No. E4422]

Bulk Flour Transporter

WE illustrate a bulk flour transporter which has been designed and built by Blaw Knox, Ltd., 94, Brompton Road, London, S.W.3, for James Nutter, Ltd. This transporter is mounted on a B.M.C. 5·1 litre diesel engine-driven articulated vehicle supplied by King and Harper, Ltd., Cambridge, and its container has a capacity of 10 tons.

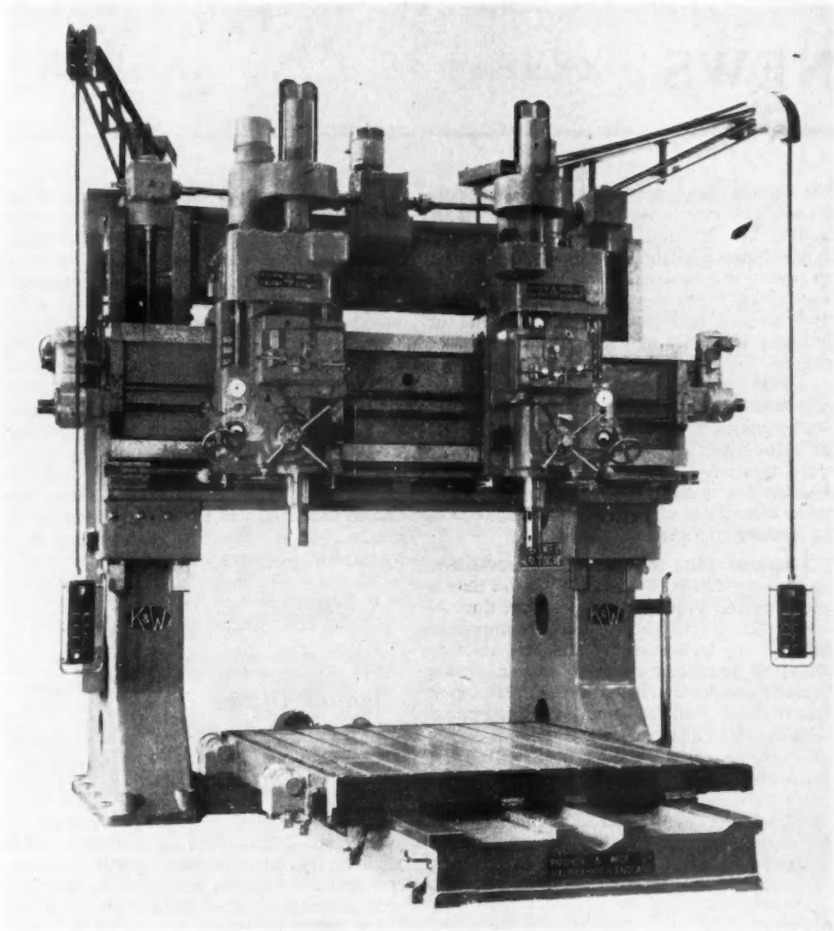
The fabricated steel container is hinged at the rear of the chassis and can be tipped up to an angle of 25 deg. by hydraulic rams to facilitate discharge. The container has a 24in wide airslide extending along the full length of its base and the steeply inclined sides are painted with epoxy resin to give a free flow of the flour down to the airslide. This airslide is of woven synthetic fibre which is non-absorbent and immune from infestation. When the container is being discharged the airslide fluidises the flour and causes it to flow to the rear and discharge into a rotary blowing valve or "seal." This valve is driven by a single-cylinder 125 c.c. petrol engine through a worm reduction box and vee belt. A Rootes blower having a capacity of 400 cubic feet of free air per minute is mounted behind the driving cab and driven by the engine power take-off.

A 3in or 4in flexible pipeline can be attached to the blowing valve and, dependent upon the length of line required, delivery can be made at up to 12 tons per hour. It is stated that in service the transporter, when using its air blower, has delivered up to 11 tons of flour an hour at a pressure of 8 lb per square inch with a vertical lift of 50ft. With an independent blower and delivering through a 350ft pipeline with a 20ft lift, flour is transferred at a rate of 7½ tons an hour at a pressure of 15 lb per square inch.

[Reply Card No. E4423]

Transmitter and receiver assembled for detecting presence of underground pipe before tracing its run

Flour transporter with container tilted at its maximum angle of 25 deg.



Duplex machine for drilling, boring, facing and screwcutting

Duplex Drilling, Boring and Screwing Machine

A LARGE duplex drilling, boring and screwing machine has been supplied by Kitchen and Wade, Ltd., Halifax, to Escher Wyss of Zurich, for drilling, boring, facing and screw-cutting operations on large cast steel turbine casings and other large components. As can be seen from our illustration, the two independent heads of the machine are arranged right- and left-hand, permitting a minimum centre distance of 2ft 10in, the maximum centre distance being 10ft. Each head is driven by a 19 h.p. variable speed motor, individually controlled through a Ward-Leonard electronic control system. A three-speed gearbox built in each head, in conjunction with the variable speed motor, gives infinitely variable spindle speeds from 2·5 to 500 r.p.m. Spindle speed is controlled by a potentiometer situated on the pendant control panel and shown on a tachometer on the head.

Each spindle is 5in diameter in the driving part, increasing in diameter to the nose, where it is bored No. 7 Morse taper. The spindles are journalled in precision taper roller bearings and supported throughout the 27in of feed by high tensile steel sleeves. The spindles have twenty rates of drilling feed, ranging from twelve to 120 cuts per inch, and ten rates of precision screwing lead ranging from four to twelve threads per inch. Quick hand adjustment to a spindle is provided through a star handle on the front of the head ; a slight forward push of any one of these handles engages the power feed. An automatic trip motion to spindle power feed is made with reference to a trip dial graduated in 1mm divisions, and a fine feed handwheel at the bottom of each head has a micrometer dial graduated in 0·02mm divisions.

Both heads can be independently traversed by power along the cross-rail of the machine at 37½in per minute rapid traverse, or 0·2in per minute for final setting. The cross-rail has 4ft of vertical power traverse on the columns through elevating screws.

The table is 13ft 1½in long by 10ft wide and has 13ft 1½in length of traverse by power at either 4ft per minute for rapid movement or 0·2in per minute for final setting. The maximum load capacity of the table is 72 tons and the maximum distance from spindle nose to table is 9ft 2¾in. Power operated locks are provided to the table and the cross-rail, the clamping operation of the cross-rail being electrically interlocked with that of the cross-rail elevation so that it is impossible to leave the cross-rail in an unlocked condition.

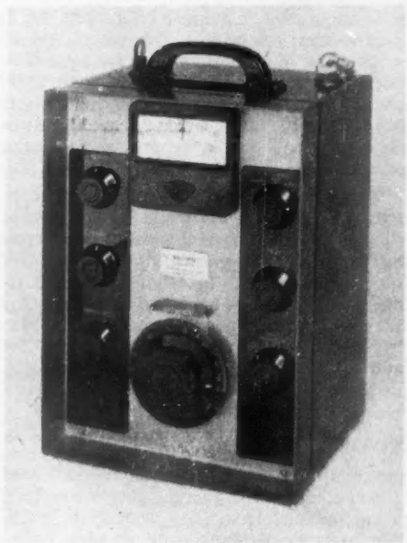
The directions and speed of both table and head traverses are controlled by multi-position rotary switches on the pendant control panels. Both of the heads and the table are fitted with optical vernier equipment manufactured by M. Hensoldt and Sohne of Wetzlar and enabling vernier readings to 0·01mm to be easily made. Optical vernier instruments for head traverse along the cross-rail are mounted on the spindle heads and are illuminated for thirty seconds on depression of a push-button. Reading of the table verniers is effected through a three-mirror periscope and the adjustment of main scale bar and vernier and also the illumination of the optical head are remotely controlled from a panel set adjacent to the periscope eyepiece.

All slideway faces of the table, heads and cross-rail backslides are covered with plastic "resofil" sheets. The gearing in the heads and reduction boxes of the traverse drives are self-lubricated by pump or oil bath, whilst the slideway faces are pressure lubricated by the one-shot system. The electrical control of the whole machine is embodied in two pendant panels, and electrical trips are fitted at the extremes of all motions. Additional trips are fitted to the heads to prevent collision, and all traverse drives are provided with slipping clutches.

Portable Beta Gauge

WHILE it is common practice for nucleonic thickness measuring equipment to be permanently associated with the machines it controls, it is often convenient and economical if such apparatus can be moved from one machine to another, or set up to monitor the product at different parts of the same machine. The portable mains operated beta gauge illustrated has been introduced by Baldwin Industrial Controls, Dartford, Kent, to meet such requirements in the production of paper, plastics, light foils and strip, and similar materials. It is used with a separate measuring head which is clamped to the machine at a convenient point and is available with various forms of mounting according to the application. The portability of the unit allows maximum utilisation, since its use can be shared by production and development departments.

The gauge is calibrated in arbitrary units proportional to weight per unit area, the user co-relating a factor for his own product. For simplicity, the gauge embodies only one radioactive source and detector. The output from the detector is compared with a calibrated reference potential and the difference in signal is amplified by a high-stability low gain d.c. amplifier. The output signal is sufficiently powerful to operate both the built-in moving coil meter and, if required, an additional external milliamp recorder. Alternative radioactive sources are supplied, according to the characteristics of the material to be measured. Depending on these factors, the useful life of a source may vary from approximately one year to twenty years.



Mains-operated portable gauge for thickness measurements by beta radiation

[Reply Card No. E4432]

Side-Discharge Dumper for Concrete

A SIDE-TIPPING dumper being made by Thwaites Engineering Company, Ltd., Leamington Spa, enables concrete to be discharged at a controlled rate whilst travelling along a site. This machine has a payload of 27 cubic feet or 30 cwt and its bucket, which is hinged on one side of the frame, is tipped by a hydraulic ram. Discharge is effected at a height of 1ft 3in above ground level, and as the machine travels along the whole of the bucket contents can be discharged in about seven seconds. The dumper is driven by a twin-cylinder diesel engine and has a maximum forward speed of 14 m.p.h. Its capacity for distributing a load from the side whilst travelling provides a quick and easy means of placing concrete without need for delivering it in heaps, which have afterwards to be levelled by hand.

[Reply Card No. E4433]

INDUSTRIAL NEWS

Wages and Hours

The fortieth annual report of the British Employers' Confederation, which was presented at the annual general meeting on Tuesday, records that last year industrial production was about 6 per cent higher than in 1958. It goes on to point out that the level of domestic prices, as measured by the retail price index, fluctuated only slightly during the year, and adds that the only broad groups of commodities and services, apart from housing, in which substantial price rises were recorded are fuel, light and transport, in which, the Confederation says, " home labour costs are a predominant element." Average weekly wage rates, the report states, rose by a little over 1 per cent during 1959, though there are indications that, with somewhat longer hours having been worked, weekly earnings went up to an appreciably greater extent.

It is against these facts, the report continues, that the present tendency towards the shortening of the normal working week must be reviewed. In presenting the case for such a shortening, the Confederation comments, trade unions have said that what they are seeking is a genuine reduction in the working week and not an increase in the number of hours worked at overtime rates. The unions have declared also that their claims could be met without any loss of production. There may be some industries, the report goes on, in which existing output per man-hour can fairly readily be increased —particularly where employers have been under pressure from their workers to maintain overtime working—and in such industries the enhanced hourly wage rates consequent on a reduction of normal weekly hours might be offset by increased productivity of labour.

But in other industries, the report suggests, there may be little scope for any appreciable immediate increase in hourly output, especially where the speed of working is more dependent on the machine than the man. In such cases, the Confederation observes, labour costs would almost inevitably rise if hours were shortened, although the more highly mechanised an industry is, the smaller is the proportion of its costs which are attributable to direct labour. In several service industries, the report asserts, there can be little prospect of offsetting any increase in hourly wage rates if the previously existing level of service is to be maintained.

Constructional Work

According to provisional figures compiled by the Ministry of Works, contractors in Great Britain carried out constructional work to the value of £509 million during the fourth quarter of last year. Although this figure is only £2,000,000 more than that for the third quarter, it is nevertheless claimed to be a record. The value of work done during the year as a whole has been provisionally estimated at £1976 million.

The Ministry says that since the beginning of 1959 the construction industries have been classified according to the 1958 edition of the Standard Industrial Classification and the figures now include the work of constructional engineering firms whose main activity is erection and not fabrication. After allowing for this change and for changes in prices, it is estimated that output in 1959 was about 6 per cent higher than in 1958. The annual increase in output from the industry has only exceeded this once since the end of the war, namely, between 1952 and 1953, when an increase of 7 per cent was achieved. In the fourth quarter there were few significant changes in the output of different kinds of work compared with the third quarter. The most significant factor was the continued increase in the amount of private housing which rose to £88,000,000, an increase of 5 per cent.

Employment in the construction industries in January this year was 20,000 more than a year earlier. Allowing for seasonal fluctuations, the employment situation improved throughout last year. Prices of building materials remained relatively stable during the last quarter of 1959 and the cost of new construction work was unchanged compared with the third quarter. The index number of the volume of production (1954=100) for the fourth quarter is 115, compared with 113 in the previous quarter. Seasonally corrected there was no change and after increasing in the earlier quarters of the year, production levelled off.

Industrial Psychology

The annual general meeting of the National Institute of Industrial Psychology was held in London on Tuesday. The annual report records steady progress in long-term research projects, though it says that some of the work has been delayed because of the Institute's inability to recruit staff with the required experience. The report states that among the questions to which the Institute hopes to find exact answers are how far a worker's satisfaction with his job affects his efficiency, how people in industry regard the opportunities and rewards offered them, in what way organisational structure affects managerial efficiency and how individuals differ in manual dexterity. The Institute is also developing new techniques for testing colour vision. Most of these inquiries, it is explained, are still in the stage of experiments with research techniques, but a test of school-leavers' dexterity on simple manipulative tasks showed that, while speed in any one test depended mostly on its nature, there was a factor of ability common to all tests and this was not general intelligence ! Work is continuing in order to see how far individual differences in this dexterity are permanent and whether it can be measured in a way useful to those responsible for selecting young workers for particular jobs.

The Department of Scientific and Industrial Research has agreed to continue financial aid for research, but the Institute now has to raise more money from subscriptions and donations to qualify even for the minimum D.S.I.R. grant of £9000 a year. The Institute, the report states, is determined to obtain the additional support necessary to earn the maximum possible grant of £12,000 a year before the end of the five years during which the aid is to be made available. The number of corporate members (industrial undertakings which join as a unit) must be increased the report emphasises, and bigger contributions will be sought from those still paying at the lower rate which applied before October, 1957. During the last year, the Institute has carried out many more attitude surveys for individual firms. In these surveys, trained investigators discover, through confidential interviews, what managers and employees think is wrong with the undertaking and their views on how it could be put right. The investigators then base recommendations to the management on the results. Such surveys often show that more systematic selection, promotion or training is needed. One large engineering company, it is stated, has now asked the Institute to carry out an attitude survey every year.

Industrial Training

The British Employers' Confederation has announced that 154 large public companies have given assurances that it is their policy to increase substantially their intake of boys to skilled occupations during the years 1961–1963. This, it is stated, is the preliminary result of an appeal made by Sir William Garrett, president of the Confederation, in a letter which pointed out that the number of school leavers in the three years would be about 20 per cent higher each year than in 1958 and that this " bulge " would add about 2 per cent to the country's manpower. Sir William stressed that industry must not lose this opportunity of increasing its skilled labour force to meet the needs of an expanding economy and of discharging its social responsibility towards the extra number of young people seeking progressive employment in the next three years. He went on to express his belief that if, in the recruitment of trainees, a clear lead was given by companies regarded as leaders in industry, other employers would follow.

In addition to the 154 promises already mentioned, there were sixty-two companies which expressed their sympathy with the objects outlined by Sir William but felt they could not associate themselves with the precise terms of his letter. Of these, fourteen said they hoped to increase their recruitment though the increase might not be " substantial " and twenty-three said they were already making a large contribution to the training of skilled workers for their industries. On the other hand, there were forty-three other companies which considered that, for various reasons, the policy as defined was " inappropriate in their particular circumstances." A further twenty-one companies replied that because of restrictions by the trade unions, they were either unable to subscribe to the policy or could only implement it if the restrictions were relaxed.

The British Iron and Steel Federation, it should be added, has carried out its own survey on the subject. This has indicated that the iron and steel industry's intake of apprentices to skilled trades will increase by more than 20 per cent over the next five years.

PERSONAL AND BUSINESS

Appointments

MR. DOUGLAS LATHAM has been appointed a director of Edwards High Vacuum, Ltd.

DR. E. A. J. HALL, M.I.E.E., has been appointed technical director of Epsylon Industries, Ltd.

MR. GORDON WRIGHT, A.M.I.Mech.E., A.M.I.E.E., has joined Electrothermal Engineering, Ltd., as chief engineer.

MR. THOMAS P. EVERETT, M.I.Mech.E., has joined the board of Hawker Siddeley Brush Turbines, Ltd., as sales director.

MR. G. O. ALLERSTON, A.M.I.Mech.E., has been appointed deputy education manager of A.E.I. (Woolwich), Ltd.

MICROCELL, Ltd., announces that Mr. W. A. Bartlett has been appointed to its board as an executive director.

MR. J. V. HUSSEY, sales manager of Bell and Harwood, Ltd., has been appointed to the board of the company as sales director.

MR. BASIL SPENCE, P.R.I.B.A., has been elected president of the Building Centre to take the place of the late Sir Giles Gilbert Scott.

MR. R. G. TOLLEY has joined the Simms Group of Companies as director and general manager of Aircraft Steel Structures, Ltd.

MR. E. J. HUDSON has been appointed divisional manager of the general services division of The Plessey Company, Ltd., Swindon Region.

SIR W. H. BAILEY AND CO., Ltd., has appointed Mr. B. D. Hayes as its technical representative to cover the East and West Ridings of Yorkshire.

MR. A. W. HIGSON, manager of the engineering department of the National Benzole Company, Ltd., has retired. He has been succeeded by Mr. R. C. Lewis, assistant manager.

THE INDUSTRIAL WELFARE SOCIETY states that Captain H. Leighton Davies, assistant managing director of the Steel Company of Wales, Ltd., has succeeded Lord Monckton as chairman of the Society and the Council.

SIR ALEXANDER FLECK has been appointed president of the Society of Chemical Industry for 1960/61, in succession to Monsieur E. J. Solvay. He will be installed as president at the annual meeting of the Society at Bristol in July.

THE MINISTRY OF AVIATION announces that Mr. E. D. Whitehead has been appointed director of electrical inspection in succession to Brigadier C. A. Zweigbergk, whose tour of duty in the Ministry will end at the beginning of April.

ENGLISH STEEL CORPORATION, Ltd., announces that Dr. C. J. Dadswell has relinquished the office of managing director of Davis and Lloyd (1955), Ltd., and has been appointed chairman. He has been succeeded as managing director by Mr. C. Muirhead.

MR. H. D. VIGERS and MR. C. J. HODGES have been appointed directors of Hoover (Electric Motors), Ltd., Cambuslang, Lanarkshire, and Mr. F. A. Austin and Mr. H. J. Furness have been appointed directors of Hoover (Washing Machines), Ltd., Merthyr Tydfil, Glamorgan.

ARUSHA INDUSTRIES, Ltd., announces that Mr. A. B. Lidderdale, M.I.Mech.E., has been appointed personal assistant to the chairman ; Mr. L. Ingham, A.M.I.E.E., has been appointed group sales manager, and Mr. A. J. Smith, A.M.I.Mech.E., has been appointed group industrial engineer.

STONE MARINE ENGINEERING COMPANY, Ltd., announces that Mr. J. A. Morton has resigned his appointment as joint managing director, but remains on the board responsible for marine sales of Stone-Vapor boilers and Stone's non-ferrous nails and rivets. Mr. C. G. Parsons has joined the board and has been appointed general manager. Mr. G. Heslam has been appointed technical sales representative for Stone-KaMeWa controllable pitch propellers.

THE NEWAGE GROUP has announced the appointment of Mr. A. D. MacKay as managing director of Newage Engineers, Ltd., and to the boards of the subsidiary companies, Newage (Manchester), Ltd., Arthur Lyon and Co. (Engineers), Ltd., H. E. Nunn and Co., Ltd., Newage Machine Tools, Ltd., and Newage Industries Incorporated, U.S.A. Mr. S. J. Harris will hold the office of executive chairman of the Newage Group, and continue as managing director of the subsidiary companies. Mr. MacKay will be located at Manchester.

Business Announcements

THE MARCONI INTERNATIONAL MARINE COMMUNICATION COMPANY, Ltd., announces that its New York depot has moved to new premises at 75, West Street, New York, 6. The telephone number remains unchanged. From April 1 the company's Hull depot will have a new telephone number, Hull 26144.

WATSON AND SONS (ELECTRO-MEDICAL), Ltd., East Lane, North Wembley, Middlesex, announces that its Industrial Division has recently taken over the distribution in the United Kingdom of "Andrex" portable X-ray units. They were previously distributed by B.I.X., Ltd., High Holborn, London, W.C.2, who will continue to provide a full radiographic inspection service.

MONSANTO CHEMICALS, Ltd., states that, as a result of an agreement with the Siemens Companies of West Germany, it is to manufacture silicon at its Ruabon, North Wales, factory. Production will begin in the last quarter of 1960. The Monsanto plant will produce float-zoned single cyrstals of high P-type resistivity or doped float-zoned single crystals of P or N-type resistivity. The company will also supply polycrystalline rod for further processing, doping and crystal forming by customers.

CHEMICAL WORKS PROJECTS, Ltd., Simon House, 28/29, Dover Street, London, W.1, has been formed by P. G. Engineering, Ltd. (member of The Power-Gas Group), Humphreys and Glasgow, Ltd., and Simon-Carves, Ltd., to supplement their normal activities by undertaking contracts for large fertiliser and chemical projects overseas. The board of directors will consist of Mr. J. P. V. Woolam, Mr. G. Gresle Farthing and Mr. R. W. Rutherford, who will be the first chairman, each having an alternate director.

THE BIRFIELD GROUP has acquired Plamac, Ltd., the privately-owned company making button machinery. Manufacture of the machines at the works of Plamac, Ltd., at Bishop Auckland is to cease and will instead be carried out on the premises of one of the companies in the Birfield Group, Kent Alloys, Ltd., Temple Manor Works, Rochester, Kent (telephone, Strood 7674/7). The board of directors of Plamac, Ltd., has resigned and has been replaced by Mr. C. E. Lovelace and Mr. E. Walker, who are also joint managing directors of Kent Alloys, Ltd.

Contracts

HUMPHREYS AND GLASGOW, Ltd., in association with Petrocarbon Developments, Ltd., has received an order for the design and detailing engineering for the first phase of a 40,000 tons per annum ethylene plant which the companies are supplying to the German Democratic Republic.

HALL, RUSSELL AND CO., Ltd., has received an order from The Walker Steam Trawl Fishing Company, Ltd., for two motor trawlers, each 108ft 6in in length by 23ft 9in beam. Propulsion of each ship will be by a British Polar MN14 two-stroke direct-reversing diesel engine, rated at 700 b.h.p., driving a Hindmarch/Berg controllable pitch propeller.

THE J. L. EVE CONSTRUCTION COMPANY, Ltd., has been awarded a contract by the North of Scotland Hydro-Electric Board for a 275kV transmission line between Beauly and Kintore. The firm has placed an order for the latticed steel towers, which will carry the line, with William Bain and Co., Ltd. The total weight of steel is likely to exceed 4000 tons.

ASSOCIATED ELECTRICAL INDUSTRIES, Ltd., Heavy Plant Division, is to supply the main drives and auxiliaries for the hot strip roughing mill, and for the four-stand tandem cold sheet mill which are being built at the Richard Thomas and Baldwins, Ltd., Spencer Works, Llanwern, near Newport. The plant, which will be worth about £1,800,000, is to be commissioned in the autumn of 1961.

The Heavy Plant Division has also received an order from the Australian Aluminium Production Commission for germanium rectifiers for use in a smelter. The order, worth more than £400,000, is for equipment with an installed capacity of 42MW for an extension to the smelter at Bell Bay, Tasmania. The rectifier output of 40,000A at 875V d.c. will provide for stand-by capacity. The equipment will consist of six units, all controlled by a single regulating transformer. A stand-by regulating transformer, to serve both the existing plant and the extension, is also being supplied. Most of the equipment will be made at Rugby.

A BRITISH CONSORTIUM comprising The English Electric Company, Ltd., Platt Brothers (Sales), Ltd., and Marples Ridgway and Partners, has been awarded a contract worth nearly £6,000,000, for the construction and equipment of a textile mill in the Sudan. The mill is being built in Khartoum for John Theodoracopoulos Company, Ltd., and is being financed from American and British sources. The civil engineering contractor is Marples Ridgway and Partners ; The English Electric Company, Ltd., will supply the diesel generating plant and all the electrical equipment for the distribution and use of the power, Platt Brothers (Sales), Ltd., will supply the spinning machinery, British Northrop, Ltd., the looms, and Sir James Farmer Norton and Co., Ltd., the dyeing and finishing machinery.

BRITISH TRANSPORT DOCKS has placed a contract for the construction of two single-storey transit sheds at No. 12 Quay, King George Dock, Hull. The new sheds, each 500ft long by 150ft wide, with associated rail and road works, will complete the modernisation of this quay. The main contract has been awarded to A. Monk and Co., Ltd. The steelwork sub-contractor is The South Durham Steel and Iron Company, Ltd.

HARBOUR AND GENERAL WORKS, Ltd., has been awarded a contract valued at £486,203 by the Minister of Transport, for the construction of a dual carriageway by-pass on the Great North Road (A.1) at Brotherton, near Pontefract, in the West Riding of Yorkshire. The by-pass, which will be about 1½ miles long, and is expected to be finished in the autumn of next year, will form part of the comprehensive general improvement of the Great North Road. The work will include a fly-over at the junction with Route A.162 and a bridge to carry the existing trunk road over the by-pass. The scheme has been prepared for the Ministry of Transport by the West Riding County Surveyor, Col. S. Maynard Lovell.

W. C. HOLMES AND CO., Ltd., chemical engineering division, Huddersfield, has received an order, valued at approximately £31,000, for the installation of a complete briquetting plant at the Kingston-on-Thames "B" power station of the Central Electricity Generating Board. This plant has been designed in collaboration with Neldco Processes, Ltd., and Conreur Ledent et Cie of Raismes, France, who will supply the press. The plant will produce 10 tons of ovoids per hour, using grit taken from the station's dust collection system, mixed with fine coal. Liquid pitch will be used as the binder. The ovoids will be burnt on standard chain grate stokers. The plant is scheduled to be in operation before the end of 1960.

COCKBURNS, Ltd., Cardonald, Glasgow, has secured an order valued at £50,000, for valves, to be supplied to the Athens Water System. The valves are from 4ft to 6ft in diameter and are made in Meehanite iron with special rubber seats, ensuring an absolutely tight shut-off without leaks, and involving minimum operating load. They are based on U.S. designs and are manufactured by Cockburns under licence. The Athens Water System is one of the most modern in Europe, and receives its supply from the 40,000,000-gallon reservoir at Marathon, 25 miles away. The system is being extended considerably to meet the needs of a greatly increased population and the industrialisation of Athens. A team of engineers from Cockburns will travel to Greece to undertake installation work.

THE GENERAL ELECTRIC COMPANY, Ltd., has received a contract from Richard Thomas and Baldwins, Ltd., for electrical equipment at the new Spencer Works at Llanwern, near Newport, Monmouthshire. This contract, which is valued at £2,250,000, includes the main drives for the finishing train of the 68in hot strip mill which will be capable of rolling steel strip at 3250ft per minute. Five of the six stands will be driven by d.c. motors each rated at 8000 h.p., and the sixth by a 7000 h.p. motor. Grid-controlled mercury arc rectifying plant, totalling in output 37·6MW, will convert the 33kV incoming supply to 1500V d.c. for the main motors. G.E.C. is also supplying a considerable amount of ancillary plant for the hot strip mill, including electric drives and equipment for the run-out tables and hot strip coilers, and the complete electrical equipment for two single-stand temper mills in the cold rolling department. Other contracts placed recently by Richard Thomas and Baldwins, Ltd., in connection with Spencer Works include one with Lodge-Cottrell, Ltd., valued at £720,000, for the blast furnace gas cleaning plant and another with Wharton Crane and Hoist Company, Ltd., for overhead electric travelling cranes. The value of this order is £300,000.

CONTINENTAL AFFAIRS

by Our Continental Editor

Leipzig Spring Fair

No. 1

THIS year's Spring Fair at Leipzig, from February 28 until March 8, attracted some 9500 exhibitors from fifty different countries. The Fair, which, as usual, comprised a technical fair as well as a sample fair for consumer goods, was held on an exhibition area totalling 3,120,000 square feet, some 2,000,000 square feet being taken up by the technical fair. Of the total, over 1,000,000 square feet were occupied by firms from outside the German Democratic Republic. These figures correspond roughly to those of last year, when participation included 6337 exhibitors from the German Democratic Republic, as well as 191 foreign trade organisations representing tens of thousands of enterprises from other Socialist countries. From the German Federal Republic 1471 exhibitors took part, and there were a further 1436 exhibitors from other Western countries and from overseas. Visitors last year numbered nearly 586,000, including 535,000 from the German Democratic Republic, and 13,649 from countries of the East. The number of West German visitors amounted to 28,756 and 8321 attended from other countries.

At the Spring Fair, the stress was on the technical fair which was held at the main Exhibition Site in the south-eastern suburb of Thonberg. The technical exhibition covered all branches of engineering, including machinery for a large variety of industries, road and rail vehicles, instruments, the chemical industries, iron and steel, mining, shipbuilding and aeronautics. Such a vast scope can be encompassed only by concentrating very largely on new developments and improved versions of existing products. In fields where the size and nature of the objects preclude an exhibition of the originals, as for instance, in shipbuilding and opencast lignite mining, full use was made of model shows to present the German Democratic Republic's considerable potential as well as the country's production targets under the current seven-year plan.

East and West German exhibits at the Fair Grounds were shown alongside one another and are entirely of a technical and industrial nature, East German consumer goods being shown elsewhere in the city centre. On the other hand, exhibitors from countries outside Germany were for the most part accommodated in various national pavilions or sections of larger halls, and these national sections comprised both technical and consumer goods. Some foreign exhibitors, however, were placed in those sections dealing with their particular fields.

A large number of visitors were attracted to the pavilion of the U.S.S.R., which occupied a central position. This year, however, the Soviet exhibition on the whole gave evidence of solid achievement rather than any very striking new departures. The exception was provided by the pioneering Russian rocket flights last year. Thus, pride of place in the central aisle was given to a large replica of the moon, presenting to the entering visitors the "invisible" side, which was photographed for the first time last autumn by the Soviet rocket.

Great interest was aroused by the exhibition of the People's Republic of China which, in 1959, celebrated the tenth anniversary of its establishment. The Chinese exhibition, which occupied the whole of the large Hall 5, sought to give an impression of life in the new China, notably the development of education and the setting up of "people's communes." In higher education and professional training much stress is laid on combining studies with actual productive work and a substantial part of the exhibition was devoted to the industrial output of technical and science students which surprised by the wide range covered by the items, from light and medium electric motors to electric and electronic instruments, analogue computers, and inorganic and organic chemicals, including such preparations as germanium crystals. The quality, and hence the value in use, of these productions cannot easily be estimated; their educational value must be very great.

Besides a full range of consumer goods,

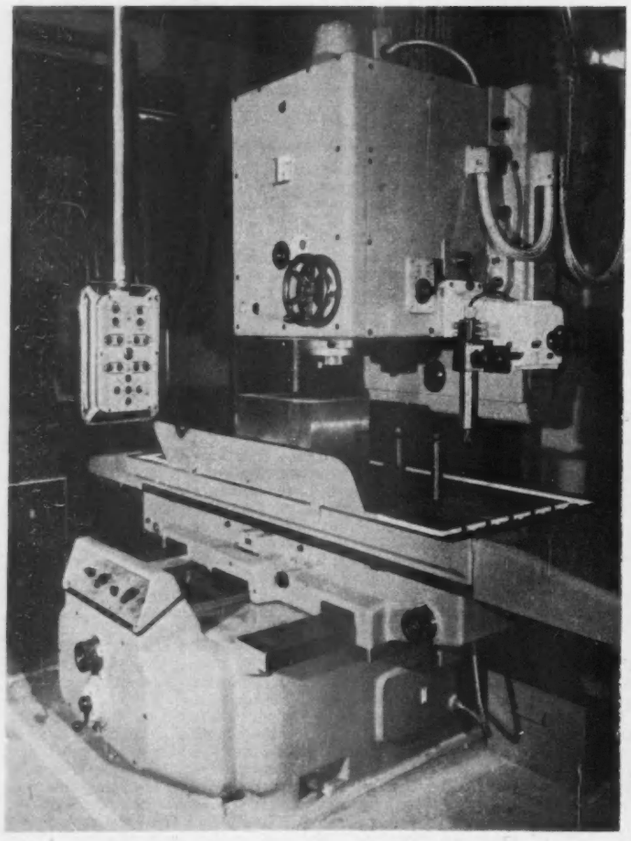


Fig. 1—Vertical milling machine with copying equipment

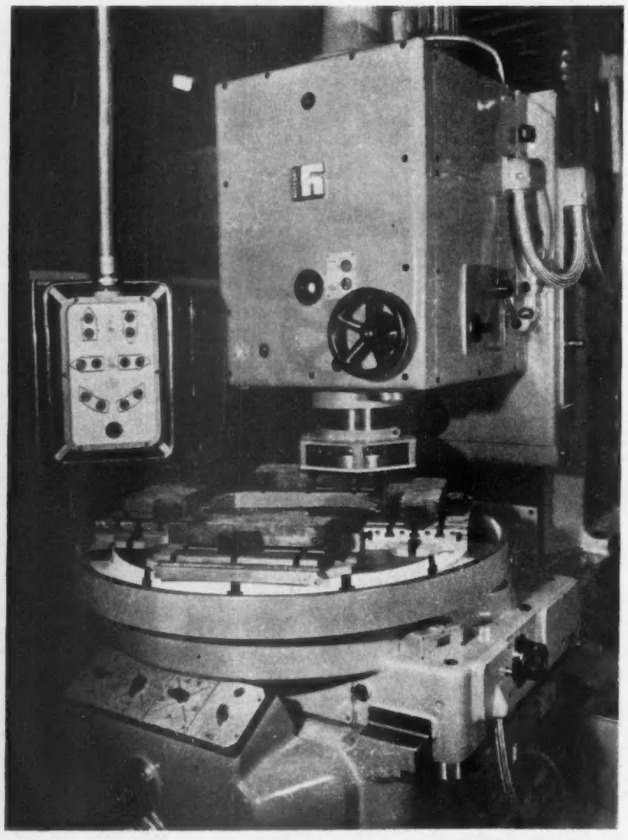


Fig. 2—Vertical milling machine equipped with rotary table

mostly of a high standard, the exhibition showed the improvements which have taken place in irrigation, power production, and in the production of technical goods.

From its 1600 large rivers, China has available a mean annual quantity of $2{\cdot}68\times10^{12}$ cubic metres of water, representing a reserve of water power of 580 million kilowatts. Some sixty large and nearly 1800 small and medium reservoirs were constructed in the last ten years, representing a total earth movement of 86,800 million cubic metres. The area under irrigation increased by 105 per cent between 1957 and 1959, from 520 million to 1070 million mu (1 mu=1/15th hectare). During the same period the installed capacity of drainage and irrigation machinery increased over five-fold, from 560,000 h.p. to 3,400,000 h.p., and the number of small rural hydro-electric stations from 544 to 7132. Protection from erosion was extended from 200,000 to 400,000 square kilometres.

Expansion of some of China's basic industries is illustrated by the following figures. In 1949, coal and steel production stood at 32,430,000 and 158,000 tons, respectively. By 1959, output of coal had risen to 347·8 million tons, and that of steel to 13,350,000 tons. Cement production during the same period rose from 660 million to 12,270 million tons. Only brief mention was made in the exhibition of the recent campaign to step up pig-iron output by the use of an enormous number of miniature blast furnaces. It is considered by many that this campaign turned out a failure owing to the indifferent quality of the iron produced. On the other hand, the expansion of China's steel capacity by orthodox techniques proceeds apace ; one of the exhibits was a full-size model of a 120-ton ingot, stated to be already in production.

There was on exhibition a wide variety of standard and medium/heavy machine tools comprising most of the main types. The designs appeared to be based on contemporary German and other foreign examples, and the workmanship and finish were excellent. As an instance may be quoted a single-column vertical boring mill with equipment for semi-automatic cycling and pre-selection of tool feeds. This machine, weighing 17·3 tonnes, has a 1400mm diameter faceplate and can machine workpieces up to a diameter of 1600mm and a height of 1000mm. There is a lateral tool post, as well as a vertical tool post, fitted to a cross rail. Faceplate speeds range from 4 to 200 r.p.m. and tool feeds from 0·045mm to 16mm per revolution. The power of the main motor is 28kW.

Some interesting new developments were seen among the East German machine tools. V.E.B. Fritz-Heckert-Werk, Karl-Marx-Stadt, showed the "Model FKrS" vertical milling machine (Fig. 1) with compound table designed for the machining of heavy and bulky workpieces. The 14kW milling head can be inclined up to 45 deg. in either direction, and is equipped with eighteen pre-selected cutting speeds. The table measures 630mm by 2000mm and has a longitudinal and transverse travel respectively of 1300mm and 500mm, while the vertical travel of the milling head is 800mm. There is a total of eighteen feeds in the two horizontal directions and in the vertical direction. The machine has a control pendant and can be supplied with electric copying device. A derived design is the "Model FRES" vertical rotary table milling machine (Fig. 2) which is identical except for the saddle being equipped with a 1000mm diameter rotating table. This machine (which can also be equipped for copy milling) allows workpieces to be loaded and unloaded at the outer stations while machining is being carried out at the inner station.

A fourteen-station fully-automatic transfer line for the complete machining of electric motor casings was shown by V.E.B. Werkzeugmaschinenfabrik Vogtland, Plauen (Vogtland). The line permits the machining of four sizes of casing, in each instance either with or without feet, and comprised one loading and one unloading station, three machining stations, four combined machining and checking stations, one pneumatic control station, one chip removal station, and three empty stations. Photo-electric controls give protection in case of tool breakage. Because of high tool setting time the finish machining is carried out alternatively on one or other of two stations. Change-over from one size of casing to another requires one shift. Up to thirty-four casings per hour can be machined.

For the accurate production of thin semi-conductor wafers (germanium, selenium, and silicon), V.E.B. Werkzeugmaschinenfabrik Auerbach has produced a machine employing diamond cutting discs which is stated to be the first of its kind which operates fully automatically. The cuttings are reclaimed from the coolant.

A range of automatic blanking and piercing machines has been introduced by V.E.B. Pressenwerk, Bad Salzungen, of which the "Pasu 40" (Fig. 3) is an example. This four-column-40-ton piercing and blanking press has an eccentric mounted inside the base which actuates the punch by way of connecting rods operating in tension. The number of strokes per minute can be steplessly controlled between 160 and 400. The material, which may be up to 160mm wide, is fed in by an automatic roller feed the speed of which is adjustable by remote control during operation. The press is equipped with an electro-pneumatic clutch and can be operated either continuously automatically or by hand, single-stroke, or reverse. A scrap shear automatically cuts up the scrap as it leaves the machine.

For the production of spherical blanks for ball bearings a combined cutting-off and cold-forging machine has been produced by V.E.B. Kaltverformungsmaschinenwerk, Karl-Marx-Stadt. This machine cuts the steel wire and cold-swages it in one operation into steel balls of up to 6·3mm diameter, at a rate of 280 per minute.

In order to facilitate the loading of railway wagons, silos, &c., Fahrzeugwerke Walter Hunger, K.G., Frankenberg/Sachsen, has brought out a high level tipping truck "HK 3000," which is shown in Fig. 5. The chassis is that of a "S 4000-1" (Kraftfahrzeugwerk "Ernst Grube," Werdau). The vehicle is a combination of high level and universal tipper, i.e. in its normal position it can tip on three sides while with the lifting mechanism raised it can discharge only towards the rear. The telescopic parallel lift mechanism moves the platform farther back as it is raised so that it overhangs the chassis still more. Built-in hydraulic jacks are lowered during discharge to ensure stability. Lifting is accomplished by two hydraulic cylinders and non-return valves are incorporated in the hydraulic circuit to provide a safeguard in case of failure of the oil pressure. The platform is tilted by means of a single telescopic cylinder which is centrally placed ; the alternative discharge directions are realised by placing pins into the respective sets of hinges. A four-cylinder piston pump supplies pressure oil through rotary piston control valves. The tipping cylinder is limited in its stroke by a control valve which also brings into action a vibrating device. The platform can be tilted in forty-two seconds to an angle of 45 deg. towards either side or 50 deg. to the rear ; it measures 3254mm by 2120mm by 400mm, and can hold about 2800 kg.

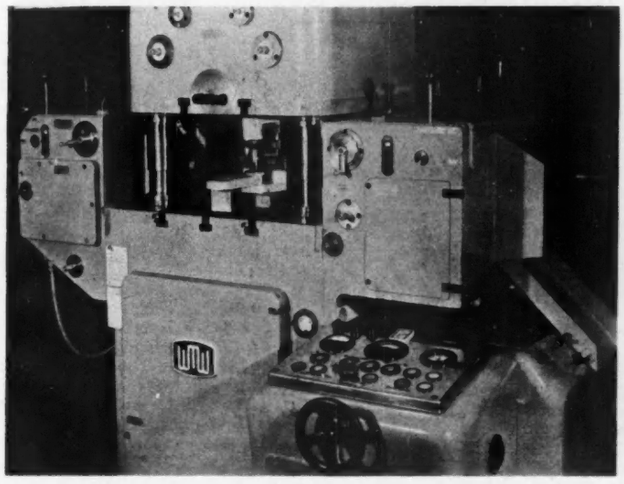


Fig. 3—Automatic piercing and blanking press

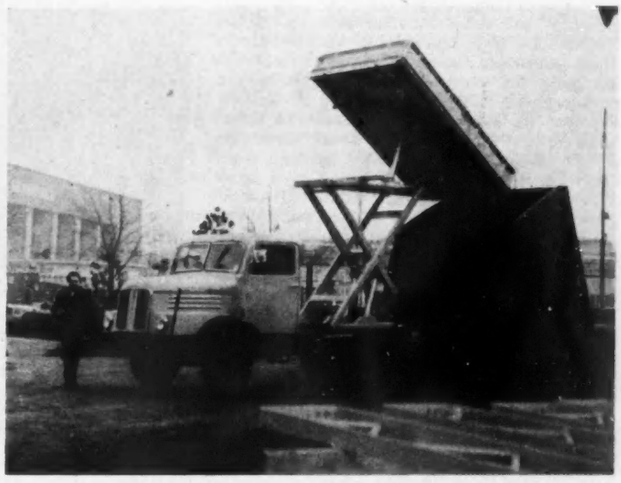


Fig. 5—High-level tipping truck

A wide range of plant and equipment for the chemical industries were to be seen, and the same was the case as regards food-processing machinery. Mention may be made of an automatic fish-curing plant introduced by V.E.B. Erfurter Mälzerei-und Speicherbau, Erfurt. This equipment works on a combined infra-red and electrostatic process and, it is stated, requires only five-and-a-half hours per ton of fresh fish as compared with eight hours previously. In place of 800 kg wood, only 15 kg of sawdust are required, and twenty manual operators are dispensed with. The plant can be extended in a simple manner so as to cope with different kinds of product or increase output.

Among the many new designs of textile machinery which were shown at Leipzig may be mentioned the "Malimo 500" thread layer sewing and knitting machine of V.E.B. Tüllmaschinenbau, Karl-Marx-Stadt. In this machine, layers of warp and weft threads are placed one on top of the other and joined by separate successive chainstitch seams. The weft threads pass through hooks mounted in brackets carried on two endless roller chains. At the point where the meshes are to be formed

CONTINENTAL AFFAIRS *(Continued)*

the array of warp threads is superimposed. A low degree of loading of the threads permits the carrying out of 1300 stitches per minute, which, with a length of stitch of 2mm and a width of the cloth of 500mm to 600mm, is equivalent to an output of 156m per hour. This is claimed to be an output rate not reached with any other process.

V.E.B. Mähdrescherwerk, Weimar, showed its "Model E675" complete potato harvester, a 2·1-tonne lightweight design with correspondingly low ground pressure. The machine has a welded tubular chassis and runs on four pneumatically-tyred wheels. Its mechanism is driven from the tractor power take-off, a 30–40 h.p. tractor being required. With a distance between rows of 62·5cm to 70cm the harvester takes up two rows of potatoes at a time. The power transmission comprises a shrouded universal shaft and two stages of reduction gearing. The lifted potatoes, tops, soil, &c. are carried to the rear of the machine by two consecutive slat conveyors which screen out the earth. In order to avoid damaging the crop, the conveyor slats are protected with rubber. At the end of the first conveyor the lifted material passes two pneumatic rollers which serve to break down the clumps of soil and separate the potatoes from the tops, which are then removed by a cross conveyor fitted with tines. From the second conveyor the crop, stones, and remaining soil are carried by a riddle wheel conveyor to the band conveyor at the top of the machine where the crop is picked out by hand and transferred by an elevator to a trailer pulled alongside. The stones are collected separately for later disposal. Excluding the tractor driver, four to six people are required to man the machine, which can harvest up to 3 hectares in eight hours.

As usual, aeronautical developments in the German Democratic Republic were shown in the pavilion of the Association V.E.B. Flugzeugbau, Dresden, N.2. This year the exhibition included a fuselage mock-up of the "152" jet airliner. This aircraft is intended to carry forty-eight to seventy-three, normally fifty-eight, passengers over short and medium distances of 1000km to 2400km, with a maximum range of 3000km. Its take-off weight has been increased to 51 tonnes and, powered by four "Pirna O14" A-1 turbo-jets, it is designed to cruise at 800km per hour. The "152" is at present being test-flown.

The pressurised cabin has a length of approximately 12m, and a height of 1970m underneath the wing and 2260mm aft of this point. The maximum width, 1070mm above floor level, amounts to 3100mm. The adjustable seats are arranged on both sides of the gangway, either in pairs, or two seats on one side and three on the other. The two forward pairs of seats face aft. Each passenger has available a flap-down table, reading light, pivoting clothes hook, and compartments for reading matter, and for the emergency oxygen breathing equipment. The cabin walls are of perforated sheet metal covered with synthetic material ("Dederon" and "P.C." fibres), which is also used for the seats. The windows are 370mm wide, 490mm high, and of oval shape. Artificial lighting is provided by a central strip fitting with fluorescent tubes. When flying at a height of 10,000m, the cabin pressure corresponds to 2000m, and the noise level to 85 dB. Between the cabin and the pilot's compartment is the galley, as well as a luggage or freight compartment. Toilets and the main luggage compartment (also pressurised) are installed aft of the cabin.

Besides the "152" mock-up were seen various sub-assemblies and items of equipment of this aircraft, as well as a "Pirna O14" A-1 jet engine. The "Pirna O14" first ran on the test bed in 1956 and passed its certification tests last August; it comprises a twelve-stage axial flow compressor, annular combustion chamber, and two-stage gas turbine. With a compression ratio of 7 : 1, the maximum mass flow is 50 kg per second. The combustion chamber is fitted with twelve burners. Maximum static thrust is 3300 kg at 8100 r.p.m., while the continuous rating is 2750 kg at 8000 r.p.m.

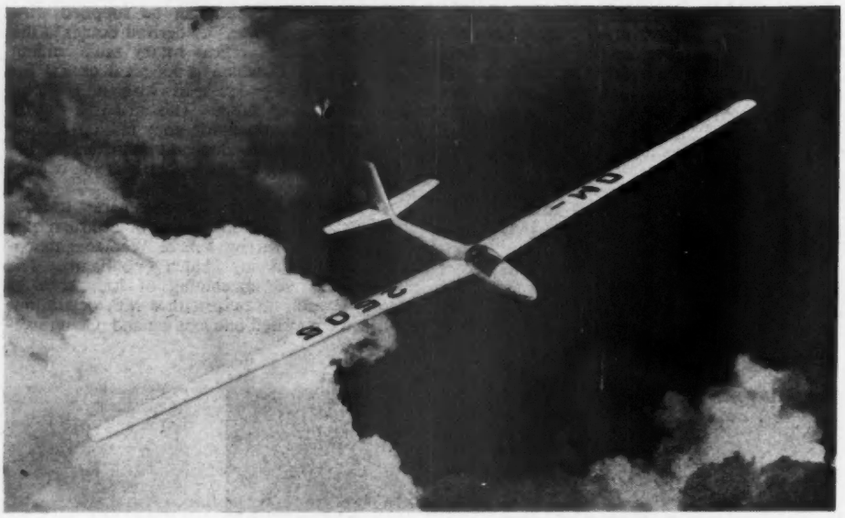


Fig. 7—Single-seater high performance glider "Libelle"

A new small gas turbine, the "Pirna O17," was shown in three different versions, of which Fig. 6 depicts the basic design. This turbine of 130 h.p. is now on the test bed. It is intended for use as a lightweight, compact source of power for emergency generators, fire pumps and similar applications, as a gas generator, or for powering helicopters and possibly light aircraft. Besides the experimental version "Pirna O17"A there was shown the "Pirna O17"D, intended for road vehicles and fitted with two heat exchangers. It weighs 200 kg. The third version exhibited, the "Pirna O17"E, is similar to the preceding but without heat exchangers; it is designed for industrial applications and weighs only 100 kg. The design comprises a single-stage radial compressor (compression ratio 1 : 3·1, mass flow 1·4 kg per second) directly coupled to a two-stage axial flow turbine. The combustion chamber is annular, with rotary fuel injection.

In Fig. 7 we illustrate the high performance glider "Libelle." This well-known machine has now been equipped with laminar profile wings of 16·50m span. The wings are covered with duralumin-clad plywood so as to obtain an optimum surface smoothness. The trailing edges are fitted with variable camber flaps. This glider can thus be equipped alternatively with standard wings of 15m and 16·5m span, or with laminar wings as described.

The laminar flow "Libelle" has a total of 14·85 square metres of wing and control surface area, and an all-up weight of 380 kg including 100 kg payload. The maximum wing loading is 25·6 kg per square metre, as compared with 21·8 kg and 22·2 kg per square metre for the standard wings. An optimum gliding coefficient of 36 is achieved at a speed of 88km per hour, and its minimum rate of descent is 0·65m per second at 76km per hour. The maximum speed is 200km per hour, and the landing speed 62km per hour.

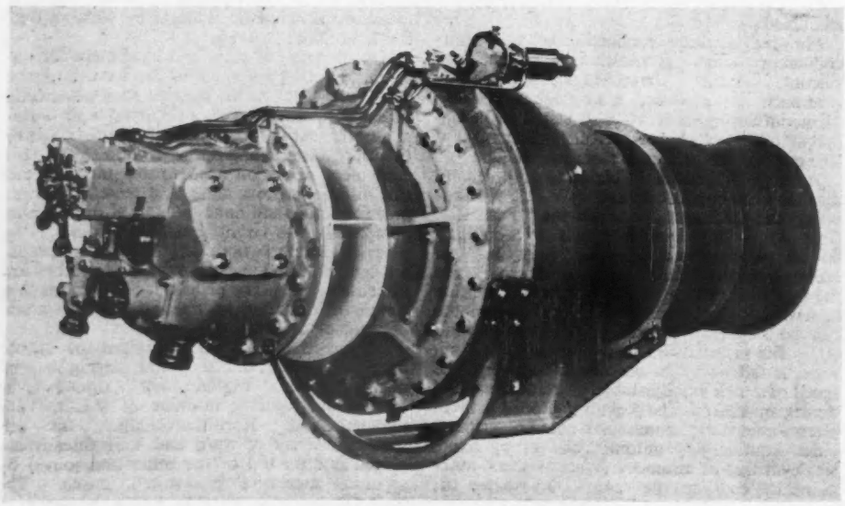
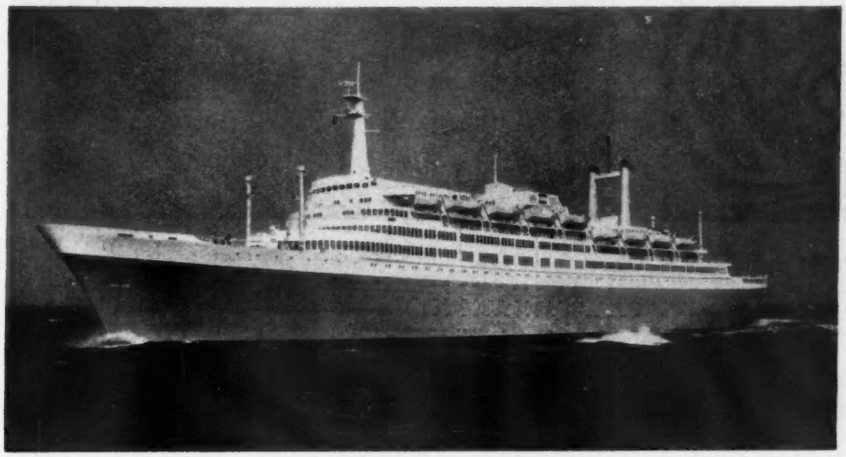


Fig. 6—Gas turbine "Pirna O17"

(To be continued)

Dutch Atlantic Liner "Rotterdam"

LAST year the new flagship of the Holland-America Line, the T.S.S. "Rotterdam," entered the company's New York–Southampton–Le Havre–Rotterdam service, and is the fifth of the name to carry the house flag of the Nederlandsch-Amerikaansche Stoomvaart Maatschappij. The ship presents a profile radically different from the conventional, and internally departs a long way from the traditional, both as regards passenger accommodation and general layout. Our illustration of the ship indicates the strongly raked soft nosed stem, the built up radar mast, the twin funnels and the open observation deck and closed observation room occupying the space usually allocated to the funnel.



Holland-America liner T.S.S. "Rotterdam"

"Rotterdam" No. 1, which began the company's Atlantic service in 1872, was 253ft long, carried a full set of sails and accommodated 288 passengers. Some 790 passengers were carried in the second of the name, which was a four-masted vessel of 3329 tons gross and 390ft in length and entered service in 1886. Eleven years later the third "Rotterdam," 470ft in length, joined the fleet and had a gross tonnage of 8186 and accommodated 1740 passengers. The fourth "Rotterdam," of 24,149 gross tons, entered service in 1908 and the ship, which had a length of 668ft, had accommodation for 1676 passengers in three classes.

The following are the main particulars of the present ship, which was launched by H.M. Queen Juliana on September 13, 1958, from the yard of the Rotterdam Drydock Company :

Length overall	748ft
Length between perpendiculars	650ft
Breadth moulded	94ft
Depth moulded to main deck	54ft 6in
Draught, loaded	29ft 6in
Displacement	31,530 tons
Gross tonnage	38,650
Deadweight	7,800 tons
Passengers	1,456
Officers and crew	776
Propelling machinery :	
Two sets of double reduction Parsons turbines	35,000 s.h.p.
Watertube boilers	Four
Steam supply	640 lb per square inch 860 deg. F.
Turbo-alternators	Four at 1350kW
Service speed	20·5 knots

The ship has eleven decks of which nine are available to passengers, and there are thirteen watertight bulkheads, eight rising to "B" deck and four to "A" deck, while the collision bulkhead extends to the lower promenade deck. These bulkheads provide the ship with an adequate degree of sub-division and for access between the fourteen watertight compartments there are forty-four sliding watertight doors, below "A" and "B" decks, which are operated electrically, from the bridge, at the door, or manually. Deckhouses and decks above the sun deck are constructed of aluminium alloy, some 200 tons being used, and 17 tons of the metal has been worked into the construction of smoke exhausts and the radar mast. The top of each smoke exhaust is fitted with a streamlined flap to project smoke and soot upward so the decks will not be soiled.

Accommodation

The whole of the accommodation for both passengers and crew is air-conditioned, and the first-class passengers have their cabins located forward on "A" and main decks over the midship length of the lower promenade deck and on the boat deck. All the public rooms are on the upper promenade deck where right forward they share the cinema, of which we include an illustration, with the tourist passengers, and occupy the balcony which has 163 seats. Aft of a foyer is the Ambassador Room, which is laid out in a circular pattern around a dance floor, and continuing aft is a large foyer which flanks the main staircase and which, because of its design, permits the two classes of passengers complete freedom of movement between their cabins and public rooms without intermingling. Six lifts, three for each class, operate in conjunction with the staircases. At the aft end of the foyer there is a library to port and a card room to starboard, and the smoking room which has settees with reversible backs set facing the windows which look on to the promenade. Connecting with the smoke room is the Tropic Bar which has a large transparent glass wall and leads into the Ritz Carlton Room. This is a magnificent room two decks in height with a curving stairway leading up to a large balcony from which there is an unobstructed view over the stern of the ship. There is a bronze dance floor and seats for about 250 passengers. It is possible to walk around this deck which is glass-enclosed for half of its length. There is further promenade space on the boat deck, while on the navigating bridge deck is the Skyroom and adequate room for sporting activities. The dining room and its associated grill room on "B" deck seats 296 at tables for two, four, six and eight.

Cabins for the tourist passengers are : forward and aft of the dining rooms on "B" deck, midships and aft on "A" deck, aft of the main foyer on main deck and aft on the lower promenade deck. The tourist public rooms extend over the length of the promenade deck and forward is the auditorium of the cinema, seating 444 and having a 35ft screen. Outside the cinema is a glass-enclosed promenade, the Ocean Arcade, which is horseshoe-shaped, and immediately aft is the lounge, which extends the full width of the ship and is asymmetrical in design with specially designed furniture placed at random. A kidney-shaped dance floor is two steps below the main level of the room which, together with adjoining Ocean Bar to port, has seats for 533 passengers. A special staircase and lift leads from this room to the captain's and deck officers' quarters on the navigating bridge and the engineer officers' quarters on the sun deck. Further aft is the main foyer and staircase, which, as mentioned before, links all passenger decks. To starboard of this foyer is the library, and aft is the Club Room having a number of bas reliefs as decorations. Centrally placed doors lead to a foyer which in turn leads into the Café de la Paix, where there is a raised diamond-shaped dance floor and a cocktail bar. Continuing aft is the Verandah, which gives on to a large open deck space with its outdoor swimming pool. To port and starboard of the Club Room, Café de la Paix and Verandah are glass-enclosed promenades, while on the sun deck there is a Sun room and excellent space for playing games. The dining room, illustrated herewith, is on "B" deck, and like the first-class room is two decks high while the furnishing of the two rooms is complementary. However, the tourist room extends for the full width of the ship to include alcoves to port and starboard. A gymnasium and a swimming pool together with Turkish baths and massage rooms are at "D" deck level.

Cabins for the crew are located amidships on "D" deck, forward of the galleys on "C" deck, forward and aft on "A" and "B" decks, and forward on main and lower promenade decks. Mess rooms for the various ratings are on "C" deck and deck space is provided right aft on the lower promenade deck. The captain has a suite on the navigating bridge, where there are also some officers' cabins ; however, most of the deck officers and engineer officers are accommodated on the sun deck where they have their private mess.

Equipment and Services

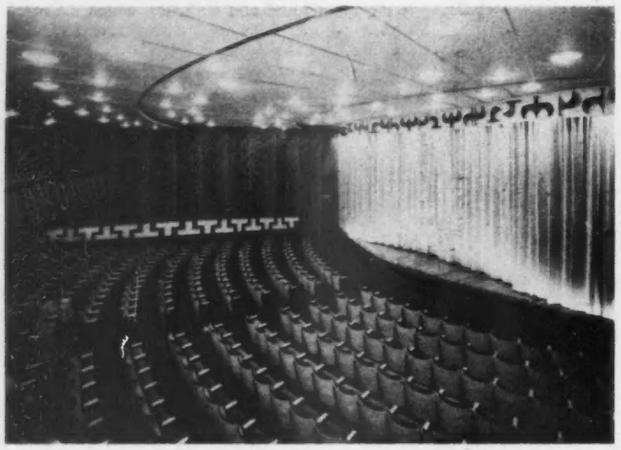
To provide for the air conditioning of cabins, public rooms and crew's quarters, there are a total of thirty-six units located throughout the ship where the air is filtered, cooled and dehumidified in the summer or heated and humidified in winter. Six pumps circulate cooled or heated water through the units and the system is able to maintain an inside temperature of 70 deg. Fah. with the outside temperature at 10 deg. Fah. The conditioned air is circulated by trunking and eleven fans exhaust air from bathrooms, &c. Twenty-three supply and the same number of exhaust fans serve the ventilating system to the kitchens, galley, laundry and store rooms.

For serving the passengers there are seven lifts, six of which are associated with the main foyer. The captain has a lift which rises from the lower promenade deck to his quarters on the boat deck, while for the engineers there is a lift from the generator room to the boat deck. A service lift links "D" deck with the boat deck. In addition, there are four small lifts for kitchen service and four escalators for steward service to the first and tourist-class dining rooms. A sprinkler system is installed for fire protection purposes, while the accommodation and the cargo holds are fitted with a combined smoke detecting and carbon dioxide fire-extinguishing installation. Carbon dioxide and foam fire-extinguishing equipment is mounted in the engine and boiler rooms. To isolate an outbreak of fire, the ship is divided into zones by fireproof transverse and longitudinal bulkheads fitted with about 160 fireproof doors. Sprayed asbestos and glass fibre not only insulate the air conditioned rooms but also give a degree of fire protection.

Denny-Brown stabilisers, operated by an electric hydraulic system and automatically controlled by three gyroscopes, are installed, and for life-saving purposes there are sixteen 36ft long lifeboats, each having a capacity of 135 persons and each provided with hand-operated propellers, and two motor lifeboats of forty-three persons capacity. All the boats are constructed of aluminium alloy and are carried under gravity davits which are designed to lower the boats on both sides of the ship against a list of 25 deg. Also on board are twenty-three rafts of reinforced plastic and capable of supporting 575 persons.

Anchor equipment includes two bow anchors

CONTINENTAL AFFAIRS *(Continued)*



Cinema showing auditorium and wide stage

Tourist class dining room

and one spare, each weighing 6½ tons and having 165 fathoms of 3¼in chain cable. For navigation purposes the ship has been mainly fitted with equipment supplied by the Sperry Gyroscope Company, Ltd. Five steering control positions are provided within the area of the wheelhouse and these are incorporated in an interlocked system which precludes the use of more than one at a time. In the centre of the wheelhouse, shown in our illustration, is the main console, having two independent control points from one of which automatic steering is available. This console also provides true course, rudder orders and angle information. Against the wheelhouse front is the "Pilot's Console," which incorporates the third steering position for both hand-electric and automatic steering through the medium of a lever control, while in each bridge wing is a bearing repeater stand equipped with an electric steering control lever for use when berthing the ship. Other navigating equipment includes a Decca Navigator for position plotting in the English Channel, North Sea and the Grand Banks of Newfoundland. Steering is effected by a 20-ton streamlined rudder operated by a four-ram hydraulic gear having two hydraulic pumps powered by 150 h.p. electric motors.

The ship has an extensive public address system and besides short wave radio-telephone transmitters and receivers, there are two automatic telephone installations, one of 100 lines for service purposes and the other of more than 700 lines for use of the passengers. For the rapid delivery of telegrams a pneumatic tube system has been installed between the radio office and the chief steward's office.

Provision has been made for the carriage of a small amount of cargo, there being 102,000 cubic feet available for dry cargo and 14,000 cubic feet for cooled cargo. Hatches numbers 1 and 2 serve the forward holds in which a total of thirty-six motor-cars can be stowed. Two refrigerated cargo rooms are located in No. 2 hold and a third room is placed aft, access being by No. 3 hatch. The rooms are air cooled and can be maintained at a temperature of 15 deg. Fah. All hatches have steel pontoon covers and for handling purposes there are four 5-ton and two 10-ton derricks operated by electric winches and a deck crane of 3 tons lifting capacity for dealing with motor-cars or baggage. The latter is handled by conveyor to the baggage room from the loading cross passage on "B" deck. Refrigerated provision rooms have a capacity of 31,350 cubic feet.

Main and Auxiliary Machinery

The main and auxiliary machinery is located in six compartments having a total length of 300ft and arranged from aft to forward as follows: engine-room, boiler room, evaporator room, generator room, air conditioning and stabiliser room and refrigerating machinery room.

The main propelling machinery consists of two sets of triple expansion double-reduction geared turbines of Parsons design, built by N.V. Koninklijke Maatschappij "De Schelde" and delivering 34,600 normal continuous shaft horsepower at 131·5 propeller revolutions per minute. One set of turbines can be seen in our illustration. The maximum power is 38,000 s.h.p. at 135·5 propeller revolutions per minute and the astern power available is 20,700 s.h.p. at 108 propeller revolutions per minute. Steam conditions at the turbine stop valve are 617 lb per square inch, while a vacuum of 29in of mercury is maintained in the condenser with sea water at 59 deg. Fah. The machinery drives two three-bladed propellers of 20ft diameter, each weighing about 23 tons.

Wheelhouse showing Sperry main steering console and pilot's console

The h.p. ahead turbine consists of a Curtiss wheel and seventeen rows of reaction blading all mounted on a solid forged heat stabilised rotor. Individual blades are fitted to the Curtiss wheel and while the reaction blades are assembled in sectors and end tightened, the clearance during operation is 0·016in and 0·047in when manuœvring. Steam supplies pass through a strainer on the way to the nozzle box which is divided into compartments with ten, two, four, and seven nozzles, the first group being always open while others can be opened to give combinations to suit different loading. Unbalanced axial thrust is taken by a thrust dummy. The bearing blocks and the thrust block casing are incorporated in the turbine cylinder and the thrust block can be moved in an axial direction by a worm shaft and two worm wheels.

Except that there is no nozzle box and Curtiss wheel the i.p. is similar to the h.p. turbine although there are only fifteen rows of end tightened reaction blading. A ring pattern governor is fitted since the h.p. astern turbine is mounted forward and there is no free shaft end available. The h.p. astern turbine is connected with the l.p. turbine by means of a flexible tooth coupling and has three rows of impulse blading, steam being supplied from a box having seventeen nozzles. Blade clearances are wide and the rotor has a thrust block at the aft end.

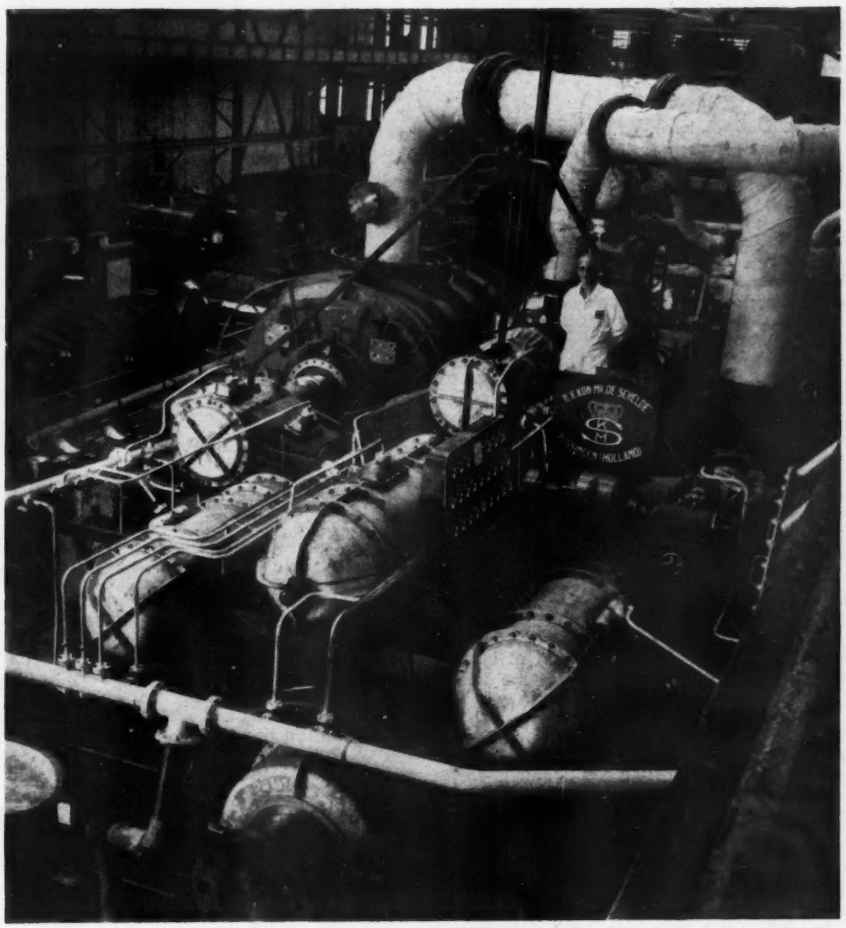
The double-flow l.p. turbine rotor carries two groups each consisting of eleven rows of ahead reaction blading, and also three rows of astern impulse blading.

Unalloyed forged steel has been used for the turbine rotors and stainless steel, including 13 per cent chromium, has been employed for both blading and nozzles. The casings are of unalloyed cast steel and the nozzle chest of cast steel containing 0·5 per cent molybdenum, while the bearings are of cast bronze lined with white metal.

The condensers, of Weir's design, are underslung beneath the l.p. turbines and maintain a vacuum of 29in at normal load with the circulating sea water at 59 deg. Fah. Each condenser, designed for a maximum water flow of 16,000 gallons per minute, has a cooling surface of 17,200 square feet and aluminium brass tubes of 0·75in external diameter by 18 S.W.G. wall thickness and packed with Crane-Wilkie packing. The tube plates are of naval brass and the shell is fabricated while the water boxes are of cast iron.

All primary gearwheels and secondary pinions are identical and the speeds of the turbines at normal output are h.p. ahead, h.p. astern, and l.p. ahead turbines 4250 r.p.m. and l.p. turbine 2980 r.p.m.

The gearing, designed by "De Schelde" uses



One set of turbines shown in the erecting shop

hardened, high-loaded wheels, all teeth being hardened and ground, and of single helical design having a small helix angle. The pinions are of cemented and hardened alloyed chrome nickel steel, but the l.p. pinion has a shrunk-on rim. The primary wheels have a forged centre and shrunk-on rim of chrome nickel molybdenum steel, while the main wheels are built up using a forged shaft, plate discs and a shrunk-on rim. The gear casing is fabricated in carbon steel.

Cross-over steam connections are fitted to provide for emergency short circuiting of steam should a turbine be temporarily out of action.

Part of the main control station of the machinery is shown in our illustration.

With the engines being well aft it was necessary from a question of space to have a compact machinery arrangement, and for reasons of trim to achieve a low weight. Compactness was achieved by adopting the three-cylinder turbine, and the total weight of turbines, condensers and gearing amounted to 350 tons, giving a power/weight ratio of 100 s.h.p per ton. In the "Nieuw Amsterdam" of similar power the comparative weight was 500 tons, so that technical progress during twenty years has enabled a weight saving of 30 per cent to be achieved. Weights of the individual items are set out below in tons.

Item	"Nieuw Amsterdam," tons	"Rotterdam," tons
Two super high-pressure turbines	18·5	—
Two h.p. turbines	36·5	19·5
Two i.p. turbines	37·5	19·5
Two l.p. turbines	130·0	58·0
Two h.p. astern turbines	—	11·5
Two condensers	72·5	83·5
Two gear cases	205·0	158·0

Steam is raised in four oil-fired watertube boilers built by "De Schelde" to the design of Combustion Engineering Inc. of America, and the following are the main particulars :

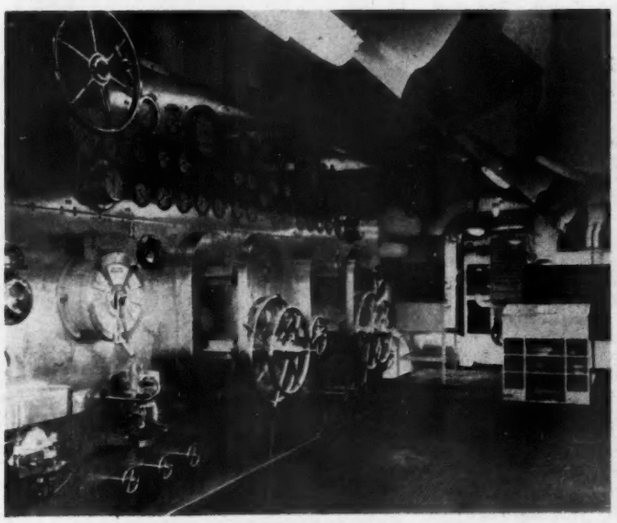
Design pressure, lb per square inch gauge	710
Operating pressure, lb per square inch gauge	640
Hydrostatic test pressure, lb per square inch gauge	1120
Steam temperature, deg. Fah.	860
Feed water temperature at economiser inlet, deg. Fah.	270
Evaporation normal, lb per hour	110,000
Evaporation, maximum continuous, lb per hour	120,000
Heating surfaces :	
Boiler and water walls, square feet	8,630
Superheater, square feet	1,550
Economiser, square feet	6,600

All pressure tubes are seamless and the steam and water drums are of fusion welded construction. The steam air heater is mounted in the duct between the F.D. fan and the boiler casing and is in two stages, the first being fed with steam at 20 lb per square inch gauge and the second with steam at 85 lb per square inch gauge. The final temperature of the air is 275 deg. Fah. Each boiler has four burners located in the front furnace wall and the fuel oil system includes a constant pressure difference valve, mounted on the common pressure line to the burners, which maintains a constant pressure difference between pressure and the return oil line. Each boiler is equipped with eleven soot blowers operated by an automatic system, and has its individual F.D. and I.D. fans. A spray pattern automatically controlled desuperheater is installed and operates when the main turbines are running at low loading.

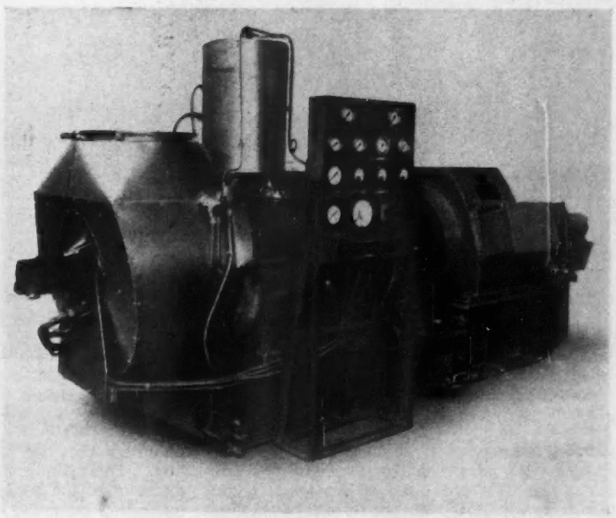
Feed water for the boilers is obtained from the fresh water distilling plant, which consists of three Griscom-Russel low-pressure sea water evaporators each having a capacity of 230 tons of fresh water per day. The fresh water is stored in tanks, having a total capacity of 1300 tons. For oil fuel there are a total of twenty-seven tanks, the overall capacity of which amounts to 3429 tons.

In the same compartment as the stabilisers are three turbine-driven Carrier freon compressors having a total cooling capacity equal to 1830 tons of ice. The refrigerating machinery serving the provision rooms and the cooled cargo spaces forward is located forward of the swimming pool, and the machinery for the cooled cargo holds aft is mounted in the shaft tunnel.

Engine-room auxiliaries are mainly electrically



Main control station



Allen 350kW gas-turbine driven emergency alternator

CONTINENTAL AFFAIRS *(Continued)*

driven and the power necessary for auxiliary machinery and for ship and hotel services is generated by four 1350kW, 440V 60 c/s geared turbine-driven alternators. Supplies at 200V are provided for the catering services, and for deck machinery and for lighting the supply is at 110V. For emergency purposes there is a 350kW Allen gas-turbine-driven alternator, illustrated herewith, in which the first stage turbine blade life is 20,000 hours. The single-shaft, open cycle turbine, consisting of a single-stage centrifugal compressor, a reverse flow combustion chamber and a two-stage axial-flow turbine, runs at 15,000 r.p.m. and drives the alternator at 1800 r.p.m. through Allen-Stoeckicht double helical planetary single-reduction epicyclic gearing.

Traction Rectifiers in Low Temperatures

For shunting duties at Basle station, the Swiss Federal Railways have in service a number of six-coupled shunting locomotives which are able to operate on tracks equipped either with the Swiss 15kV or French 25kV electrification systems. We illustrate one of two locomotives designed and built for these duties by the Ateliers de Sécheron, Geneva: they are powered by a single traction motor driving through a jackshaft and side rods. The motor current is supplied by two twin-anode pumpless, air cooled steel tank rectifiers connected in push-pull. On either traction voltage the rectifier voltage is the same, and since each system has a different frequency (16⅔ c/s and 50 c/s), frequency-sensitive relays are used to select the appropriate input tappings to the transformer.

The Sécheron rectifiers contain a chemically inert gas which does not combine with the metallic inner surfaces of the tanks, as do the other residual gases released during operation of a rectifier. Its function is to ensure ionisation in the tank at low temperatures, for in these circumstances there is a limiting value to the current which the rectifier can pass without instability. Beyond this point there is a sudden increase in the arc drop, accompanied by a fall in current, and this effect is repeated as a series of oscillations in voltage and current, maintained by the inductance in the circuit. At normal operating temperatures this limiting current value is a multiple of the nominal current, but the

Swiss Federal Railways dual-frequency shunting locomotive with rectifiers containing an inert gas

mercury pressure at 18 deg. Cent. and below is such that the relationship is reversed. The rare gas is therefore introduced at a pressure above that necessary for the rectifier to pass its nominal current with mercury alone, and since it does not condense, it continues to sustain the arc current even at temperatures much below freezing point. It is stated that the rare gas filling is retained in the rectifier indefinitely, and that it has been detected in the rectifiers of mobile substations after years of service in the open air.

The foregoing characteristics have made preheating for the shunting locomotive rectifiers unnecessary. Tests with an identical rectifier have shown that it can operate without instability on an overload of two-and-a-half times its nominal current, in a temperature of −44 deg. Cent. Since going into service one of the locomotives has run experimentally for more than six months with only one rectifier in action, and no faults were experienced in that time. The rectifiers in the second locomotive have now been equipped for grid control to provide the large number of voltage steps desirable in shunting. Similar rectifiers, also with grid control, have been ordered from Sécheron for ten a.c./d.c., two-frequency, four-voltage locomotives for shunting at other Swiss frontier stations.

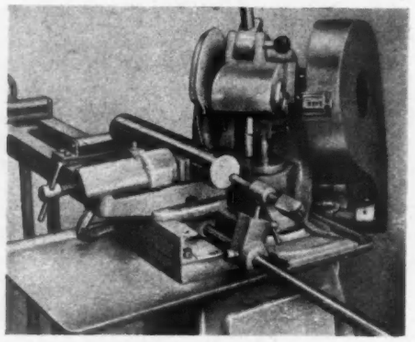
Tube Cutting Machine

A dual-purpose, high-speed tube cutting machine made by Eyring and Scheelke, Hamburg-Altona S, is being marketed in this country by Embassy Machine and Tool Company, Ltd., 248, Watford Way, Hendon, London, N.W.4. The "Horoma" cutting machine is stated to cover a range of diameters from ¼in to 3in with up to ¼in wall thickness, when cutting at right-angles to the tube axis, or up to 2⅜in diameter when cutting at 45 deg. to the axis. Non-circular sections and profiles can also be cut up to 2¼in by 2in and 4in by 1¼in.

For cutting tubes at right angles, a cutting disc is employed, the sharp edge of which is forced against the tube, which is supported on rollers. There is thus no wastage of material in the cutting. The angle of the disc employed varies according to the material to be cut, from 11 deg. for copper to 47 deg. for hard steel. The support rollers are in two sizes, for tubes of ¼in to 1in diameter, and 1in to 3in diameter, which are interchanged simply by reversing the roller supports. No clamping of the tube is required, so that it can be fed forward immediately on completion of a cut.

For angular cuts the cutter head can be swivelled through up to 45 deg. A saw replaces the disc cutter, and a quick-mounting hydraulic vice is used in place of the roller support. The drive to the disc or cutter is from a two-speed, 700/1400 r.p.m., motor through a vee-belt and chain reduction transmission. For sawing, the speed is halved by pole-changing of the motor.

Our illustration shows the layout. Movement of the cutter head is effected by a hand lever. An oil cylinder is used to limit the movement of the cutter head, which is pin-jointed to the piston rod of the upper piston. There is also a lower piston which is similarly pin-jointed to a lever loaded by a tension spring. When lowering the cutting head by means of the hand lever, pressure is exerted on the oil cylinder; part of the oil enters the vice cylinder through a flexible hose. This cylinder has two and a half times the diameter of the cutter head cylinder, giving an intensified clamping force. Continued downward movement of the hand lever brings the saw into contact with the work; stability of the cutter head is stated to be maintained by the force exerted by the compensating spring.



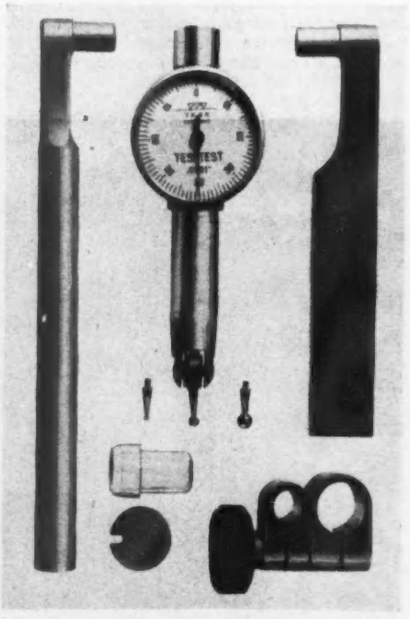
Tube cutting machine shown set up for angular cuts on a round section, using a circular saw. A hydraulic vice clamps the workpiece. For right-angle cuts of tubes, a disc cutter is employed

The main drive also actuates a cooling pump, the pump being released when the pressure on the cutter lever is relaxed, so that no coolant is being pumped except during the working cycle. A swarf settling tank and filter are fitted.

When not in use, the vice is hung from the side of the machine so that the hydraulic hose need not be disconnected. The workstop, seen in the illustration, is adjustable in three planes and is reversible. One end is plain for solid workpieces; the other is for tubes during right-angle cutting, when friction between the revolving tube and the stop is reduced by having the stop fitted with a roller.

Dial Test Indicator

A dial test indicator reading to 0·0001in has been put on the market by Tesa S.A., Renens, Switzerland (U.K. agent: Matchless Machines, Ltd., 18, Bolton Street, London, W.1.). The instrument, here shown with accessories, has a 0·9in diameter dial and a range of ±0·08in. The clamping device allows the indicator to be held rigidly at either the head or the body.



Dial test indicator and clamps. The indicator reads to 0·0001in over a range of ±0·08in

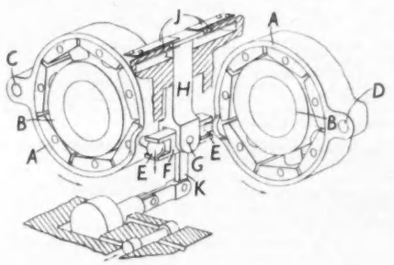
BRITISH PATENT SPECIFICATIONS

The dates printed are those of application and publication on completion. Copies of specifications may be obtained at the Patent Office Sales Branch, Southampton Buildings, Chancery Lane, W.C.2, 3s. 6d. each

FUEL PUMPS

828,016. May 22, 1958.—FUEL PUMP ARRANGEMENTS, Dowty Fuel Systems, Ltd., Arle Court, Cheltenham, Gloucester. (*Inventor : Stanley Ralph Tyler.*)

This invention relates to fuel pumps particularly for use with aircraft engines. Its object is to provide a double fuel pump arrangement to reduce the possibility of pump failure and a single control which normally acts on both pumps, but which during failure of either can equally well act on the serviceable pump. One example is described with reference to the accompanying diagrammatic drawing. A pair of variable displacement fuel pumps side by side are driven through separate snafts each of which includes a shear neck which will break on application of excessive torque. Each pump is of the radial rotating cylinder block type which includes a track ring *A*, of variable eccentricity disposed around the cylinder block *B* and engaged by slippers which reciprocate pistons within the cylinders. Each track ring is pivotally mounted at an external position respectively *C* and *D* so that eccentricity variation is obtained by movement of



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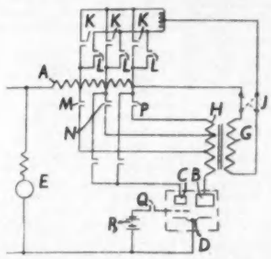
the ring. At a position on each track ring diametrically opposite to the pivot is a ball-ended member *E*. A lever *F* extends between these ball members and engages them by forked ends. The centre of the lever is located by a pivot *G* which is carried in the bifurcated end of a rod *H*. The rod is slidably mounted in a housing and its head is engaged by leaf springs *J* each tensioned to a predetermined load and located by stops at the normal position of the rod, such that the rod may be displaced axially only by the application of a force which exceeds the tension of one of the springs. For angular movement of the lever *F* an extension *K* is provided, and connected through a pivoted link to a servo piston. The above described pump arrangement is intended primarily for use with an aircraft gas turbine. When in operation, normally both pumps deliver their outputs to a common passage through non-return valves. Each pump will deliver fuel at substantially equal rates, these rates being controlled by the angular position of the lever *F* as adjusted by the servo piston. In the event that one pump becomes seized the drive shaft will break and it will be found that the track ring remains fixed in position. Movement of the servo piston to vary pump output will then cause pivotal movement of the lever about the ball joint *E* of the fixed track ring, the rod *H* carrying the lever fulcrum moving axially against the loading of the leaf springs so that the track ring of the operative pump may be adjusted by movement of the servo piston to give the output desired. In the case where one pump fails to deliver fuel but at the same time does not remain seized and does not lock its track ring in position then adjustment of fuel output will take place by normal angular movement of the lever about its fulcrum, the serviceable pump delivering the whole output.—*February* 10, 1960.

ELECTRIC TRACTION

827,722. May 16, 1955.—ALTERNATING CURRENT TRACTION EQUIPMENTS, Metropolitan-Vickers Electrical Company, Ltd., St. Paul's Corner, 1–3, St. Paul's Churchyard, London, E.C.4. (*Inventors : James Kinghorn Brown and Derek Harry Vertigen.*)

This invention provides a means of tap-changing in a.c. traction equipments having d.c. motors fed by rectifiers. Such an arrangement is shown in the drawing, where *A* is the secondary of the main transformer ; and main and auxiliary anodes and the cathode of one rectifier are shown at *B*, *C* and *D* respectively. In order to provide full-wave rectification to traction motor *E* (representing one or more machines in parallel or series-parallel), a second rectifier and secondary winding would be required. At *G* and *H* are seen the windings of an auxiliary transformer, the primary of which can be connected by reverser *J* so as to assist or oppose the voltage of main transformer secondary *A* in the rectifier and motor circuit. In this way, in conjunction with tapping switches *K*, *L*, several voltage steps can be



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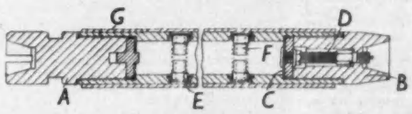
provided while the power circuit remains connected to one of the secondary tappings through tapping switches *M*, *N*, *P*. In changing the motor circuit connection from one tapping to another for continuing the notching sequence, control switch *Q* is closed so as to apply a blocking voltage from d.c. source *R* to the rectifier grid. Rectifier auxiliary anode *C* is then connected to the second tapping on *A* through an auxiliary tapping switch and *Q* is opened, whereupon the motor current is transferred to the auxiliary anode. On closing tapping switch *N* the main anode is connected to the second tapping via the auxiliary transformer secondary as before. Reclosure of *Q* cuts off anode *C* and the auxiliary tapping switch through which this anode has been supplied is reopened. Transition is then complete, enabling *Q* to be opened in its turn. At this stage the voltage injected by auxiliary transformer winding *G* opposes that from the main transformer secondary, and is then progressively reduced, reversed and increased as before. In an alternative scheme, rectifier conduction is not controlled by a grid, but by applying to the auxiliary anode, through a further transformer, a voltage opposing that from the main transformer. These arrangements enable the control of anode conduction to be accomplished by switches operating at voltages and currents which allow them to be designed to function without any considerable maintenance attention, whereas the tap-changing switches which carry the main traction motor current are not required to open or close while carrying that current.—*February* 10, 1960.

MANDRELS

827,664. September 6, 1957.—MANDRELS, Strachan and Henshaw, Ltd., Whitehall, Bristol, 5. (*Inventor : Ernest George Godsell.*)

A mandrel according to this invention is suitable for use in a machine for winding paper on to or off a core, which may be a tube of cardboard or other material. The drawing shows a fragmentary longitudinal section of one form of mandrel. A steel tube is provided at one end with a plug *A* and



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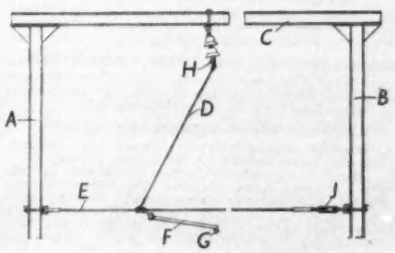
at the other end with a plug *B* having an air sealing device *C*, and an inflation valve *D* through which air is supplied to the tube. The tube has at several positions along its length and around its periphery apertures. At each aperture there is an elastic sealing element *E* comprising a circular diaphragm of rubber which has a peripheral flange located in an annular groove in the wall of the aperture. Each element has a circular recess formed in its inner face. A locating sleeve, *F*, at each element has its axis substantially diametrically of the tube. The outer end of each sleeve is slidable in the circular recess in the element *E*, and a helical compression spring maintains the outer end of the sleeve within the recess but without forcing the sleeve against the diaphragm. In use, a tube *G*, which may be made of cardboard and upon which a web of, for example, paper is to be wound, is placed upon the steel tube which is then filled with air under pressure, through the inflation valve. The elastic elements are deformed and urged radially outwardly of the apertures. The outer faces of the elements will be pressed tightly against the inside face of the tube and the tube *G* will be held tightly on to the steel tube.—*February* 10, 1960.

RAILWAY ELECTRIFICATION

827,593. July 25, 1955.—CONSTRUCTION OF OVERHEAD ELECTRIC TRACTION SYSTEMS, British Insulated Callender's Cables, Ltd., Norfolk House, Norfolk Street, London, W.C.2. (*Inventors : Arthur George Sweetland and John Lionel Coppack.*)

In railway overhead systems the catenary wire to which the contact wire is attached by droppers, or the main and auxiliary catenary wires in a compound catenary overhead system, are often supported by rigid or flexible cross span members. Another example of a cross span member in a railway overhead system is a cross span wire to which are attached steady arms designed to hold the contact wires in position over the tracks. Here insulators are inserted to avoid short-circuiting two or more contact wires and connecting them to earth. In accordance with this invention, a cross span member consists of a rod of a thermosetting or cold setting synthetic resin reinforced with glass filaments which lie substantially parallel to one another throughout the length of the rod, in such a way that the glass reinforcement is



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distributed throughout the cross section of the rod. The drawing shows the use of the cross span rods in a system for a double track line. The main supports are metal poles *A* and *B*, spaced at intervals along each side of the track, the distance apart of the poles measured transversely to the track being 40ft. Between each pair of poles there are two cross span members, the upper member *C* supporting droppers *D* and the lower member *E* carrying steady arms *F* for the contact wires *G*. Only one contact wire is shown. The upper cross span member *C* is a girder and the lower cross span member *E* is a glass fibre reinforced rod of thermosetting or cold setting synthetic resin. The dropper *D* is suspended from the girder *C* by a string insulator which also carries the catenary cable *H*. The rod *E* is attached directly to a bracket on the pole *A* and is attached to the pole *B* by a similar fitting and a turnbuckle *J*, by which the appropriate tension can be applied to the rod. The rod *E* is of $\frac{1}{2}$in diameter and the material from which it is made (continuous glass filaments embedded in a polyester resin) has a Young's Modulus of about $5{\cdot}5\times10^6$ lb per square inch. This rod can be bent into a circle of a minimum radius of about 9ft without damage. The system described has the advantage over similar systems, in which the lower cross span is a steel hawser, that the insertion of insulators in the cross span and in the steady arms is completely eliminated. The resin bonded glass fibre is highly resistant to corrosion and will withstand high temperatures to which it is subjected during the passage of steam locomotives along the tracks.—*February* 10, 1960.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office not later than a fortnight before the meeting. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

ANTIQUARIAN HOROLOGICAL SOCIETY

Fri., March 18.—Science Museum, South Kensington, London, S.W.7, Discussion on the work of the Ellicotts, 7 p.m.

ASSOCIATION OF SUPERVISING ELECTRICAL ENGINEERS

Tues., March 15.—LONDON NATIONAL LECTURE: Manson House, 26, Portland Place, London, W.1, "The Role of the Engineer and of the Architect in the Planning of Electrical Installations," Discussion, 6.30 p.m. ★ ALDERSHOT AND DISTRICT BRANCH: Queens Hotel, South Farnborough, Hants, "Manufacture and Uses of Mineral Insulated Cable," G. E. D. Redman, 7.30 p.m. ★ NEWCASTLE UPON TYNE AND DISTRICT BRANCH: Roadway House, Oxford Street, Newcastle upon Tyne, Films, 7.30 p.m.

Wed., March 16.—NOTTINGHAM BRANCH: E.M.E.B. Showroom Theatre, Carrington Street, Nottingham, "Modern Crane Control Gear," W. G. Stoner, 7.30 p.m. ★ S.W. LONDON BRANCH: Visit to B.B.C. Television Studios, Wood Lane, 2.30 p.m. ★ WOLVERHAMPTON AND DISTRICT BRANCH: Chamber of Commerce, District Bank Chambers, Lichfield Street, Wolverhampton, "Variable Speed Drives from A.C. Mains," V. W. Press, 7.45 p.m.

Thurs., March 17.—OXFORD AND DISTRICTS BRANCH: Reactor School, A.E.R.E. Harwell, "Earthing and Earth Leakage Protection of Electrical Installations," J. A. Robbins, 5.45 p.m.

Fri., March 18.—STOKE AND CREWE BRANCH: Royal Hotel, Crewe, "Modern Trends in Industrial and Commercial Lighting Installations," V. Heydon, 7.30 p.m.

BRITISH COMPUTER SOCIETY

Tues., March 15.—LONDON BRANCH: Northampton College of Advanced Technology, St. John Street, London, E.C.1, "Axis Transformation Using Analogue Equipment," N. Doveton, 2.30 p.m.

BRITISH INSTITUTION OF RADIO ENGINEERS

Mon., March 14.—RADAR GROUP: London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, Discussion on "Short Range Navigational Aids," 6.30 p.m.

Wed., March 16.—S. WALES SECTION: Welsh College of Advanced Technology, Cardiff, "Recent Developments in Printed and Potted Circuits," H. G. Manfield, 6.30 p.m.

CEMENT AND CONCRETE ASSOCIATION

Tues., March 15.—Technical College, Shorncliffe Road, Folkestone, "Introduction to Programming and Progressing," A. E. Chittenden, 7.15 p.m.

Thurs., March 17.—College of Art and Building, Lime Grove, Hammersmith, "Building High," N. Wakefield, 7.15 p.m.

COMBUSTION ENGINEERING ASSOCIATION

Thurs., March 17.—MIDLAND REGION: Exchange and Engineering Centre, Stephenson Place, Birmingham, 2, "Research Towards Improving Mechanisation and Automatic Control in Industrial Coal Fired Boilerhouses," G. G. Thurlow, 10.15 a.m.

COUNCIL OF INDUSTRIAL DESIGN

Thurs., March 17.—British Rayon Research Association, Heald Green, Manchester, One day conference on "Industrial Design and Textile Machinery," 10.30 a.m.

DIESEL ENGINEERS AND USERS ASSOCIATION

Thurs., March 17.—Institute of Marine Engineers, The Memorial Building, 76, Mark Lane, London, E.C.3, "Factors Governing Turbocharger Design," C. L. G. Worn, 2.30 p.m.

ILLUMINATING ENGINEERING SOCIETY

Mon., March 14.—SHEFFIELD CENTRE: Grand Hotel, Sheffield, "Television Studio Lighting," R. W. Koplick, 6.30 p.m.

Tues., March 15.—LIVERPOOL CENTRE: Merseyside and N. Wales Electricity Board Industrial Development Centre, Liverpool, "An Architect's Impression of the Brussels Exhibition," J. G. R. Sheridan, 6 p.m. ★ N. LANCASHIRE GROUP: Demonstration Theatre, N.W. Electricity Board, 19, Friargate, Preston, Annual General Meeting, 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN

Mon., March 21.—BEDS AND HERTS SECTION: Britannia Iron and Steel Works, Ltd., Bedford, "Automatic Moulding and Pouring Plant," C. Zehnder, 7.30 p.m.

Wed., March 23.—Constitutional Club, Northumberland Avenue, London, W.C.2, "Review of the Work of the I.B.F. Technical Council on the Effect of Cooling Rate on the Properties of Grey-iron Castings," M. M. Hallett, 7.30 p.m.

INSTITUTE OF FUEL

Wed., March 16.—YORKSHIRE SECTION: Royal Victoria Hotel, Sheffield, "Fuel Technology and the Future," M. W. Thring, 2.30 p.m.

INSTITUTE OF MARINE ENGINEERS

Mon., March 14.—WEST OF ENGLAND SECTION: Smith's Assembly Rooms, Bath, "Some Notes on Recent Reduction Gears for Propulsion Purposes," S. Archer, 7.30 p.m.

Tues., March 15.—EDUCATION GROUP: The Memorial Building, 76, Mark Lane, London, E.C.3, Annual General Meeting followed by "The Part the Institute Should Play in Relation to Education," A. F. Smith, 5.30 p.m.

INSTITUTE OF NAVIGATION

Fri., March 18.—Royal Geographical Society, 1, Kensington Gore, London, S.W.7, "The American Air Traffic Control Programme," Hans Giesecke, 5.15 p.m.

INSTITUTE OF REFRIGERATION

Wed., March 16.—Ditton Laboratory, Larkfield, Nr. Maidstone, Kent, All-day symposium on "Construction of Cold Stores for Fruit," 10.30 a.m.

INSTITUTE OF ROAD TRANSPORT ENGINEERS

To-day, March 11.—SOUTH WALES CENTRE: South Wales Institute of Engineers, Park Place, Cardiff, "Air Suspension," V. E. Gough, 7.15 p.m.

INSTITUTE OF SHEET METAL ENGINEERING

Tues., March 15.—S.W. BRANCH: Department of Engineering, The University, Bristol, Discussion on "The Designer versus the Production Engineer," 7 p.m.

Wed., March 16.—N.W. BRANCH: Engineers' Club, Albert Square, Manchester, Annual General Meeting and Film Show, 7 p.m.

INSTITUTE OF WELDING

Wed., March 16.—N. LONDON BRANCH: 54, Princes Gate, London, S.W.7, "Improved Steels and their Weldability," J. F. Wilkinson, 7.30 p.m.

INSTITUTION OF AGRICULTURAL ENGINEERS

Mon., March 14.—WESTERN CENTRE: Lackham School of Agriculture, Lacock, Wilts, "Grain Damage in Combining," F. Mitchell, 7.30 p.m.

INSTITUTION OF CIVIL ENGINEERS

Tues., March 15.—Royal Institute of British Architects, 66, Portland Place, London, W.1, "Impact of Motorways on Cities," F. Gibberd and R. Nicholas, 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS

To-day, March 11.—NORTH SCOTLAND SUB-CENTRE: Robert Gordon's Technical College, Aberdeen, "Silicone Electrical Insulation," J. H. Davis, 7.30 p.m.

Sat., March 12.—LONDON GRADUATE AND STUDENT SECTION: Visit to Big Ben Clock Tower, 10.30 a.m.

Mon., March 14.—INFORMAL MEETING: Savoy Place, London, W.C.2, Discussion on "Should Engineers be encouraged to take up Administrative Positions early in their Careers?" opened by K. E. Greene, 6 p.m. ★ E. ANGLIAN SUB-CENTRE: Electric House, Ipswich, "Some Engineering Aspects of Automatic Control," S. H. Dale, 6.30 p.m. ★ N.E. MEASUREMENT AND ELECTRONICS GROUP: Rutherford College of Technology, Newcastle upon Tyne, Discussion on "Component Reliability," 6.15 p.m. ★ S. MIDLAND SUPPLY AND UTILISATION GROUP: College of Technology, Gosta Green, Birmingham, "Turbo-Generator Performance under Exceptional Operating Conditions," F. H. Birch, 6 p.m. ★ WESTERN CENTRE: Gloucestershire Technical College, Cheltenham, "Silicone Electrical Insulation," J. H. Davies, 6 p.m. ★ READING CENTRE: George Hotel, King Street, Reading, "The Protection of High-Voltage Systems from Lightning Faults," R. H. Golde, 7.15 p.m.

Tues., March 15.—MEASUREMENT AND CONTROL SECTION: Savoy Place, London, W.C.2, "Fast-Response Transistor Chopper-Type Amplifier with Low Carrier Frequency," I. C. Hutcheon and D. Summers, 5.30 p.m. ★ N. MIDLAND CENTRE UTILISATION GROUP: Y.E.B., Market Street, Huddersfield, Paper from the symposium on "The Provision of Adequate Electrical Installations in Buildings," J. A. Sharp, 6.30 p.m. ★ CAMBRIDGE ELECTRONICS AND MEASUREMENT GROUP: Cavendish Laboratory, Free School Lane, Cambridge, "The Decca System of Navigation," C. Powell, 8 p.m. ★ N.W. UTILISATION GROUP: Engineers' Club, Albert Square, Manchester, "Discrimination between H.R.C. Fuses," E. Jacks, 6.15 p.m. ★ S.E. SCOTLAND SUB-CENTRE: Carlton Hotel, North Bridge, Edinburgh, "Lighting," F. A. Benson, 7 p.m. ★ S. MIDLAND CENTRE: College of Technology, Gosta Green, Birmingham, "The Teaching of Magnetic Amplifier Theory," K. C. Parton, 6 p.m. ★ S.W. SUB-CENTRE: S.W. Electricity Board, 3, Bedford Street, Exeter, "The Application of Low-Pressure Resins to some High-Voltage Switchgear Designs," T. R. Manley, K. Rothwell and W. Gray, 5 p.m.

Wed., March 16.—SUPPLY SECTION: Savoy Place, London, W.C.2, "An Electrostatic Dust Monitor," D. H. Grindell, 5.30 p.m. ★ N. IRELAND CENTRE: Sir William Whitla Hall, Queen's University, Belfast, "Electrical Machines," M. G. Say, 7.30 p.m. ★ SOUTHERN CENTRE: Technical College, Brighton, "Television Recording," J. Redmond, 6.30 p.m. ★ N. MIDLAND CENTRE JOINT MEETING WITH SHEFFIELD SUB-CENTRE: Co-operative Hall, Barnsley, "The Reliability and Life of Impregnated-Paper Capacitors," J. P. Pitts, 7 p.m. ★ N.W. ELECTRONICS AND COMMUNICATIONS GROUP: Engineers' Club, Albert Square, Manchester, "Data Processing," J. C. Gladman, 6.15 p.m.

Fri., March 18.—LONDON GRADUATE AND STUDENT SECTION: Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Annual Joint Meeting, Address by Sir George Edwards, 6.30 p.m.

INSTITUTION OF HIGHWAY ENGINEERS

Wed., March 16.—YORKSHIRE AND LINCOLNSHIRE BRANCHES: Hotel Metropole, Leeds, "Research and its Application on Road Construction," Messrs. Fisher, Lee and Millard, 6.30 p.m.

Fri., March 18.—N.E. BRANCH: University Science Laboratories, Durham, "Mining Subsidence with special reference to Highways," R. J. Orchard, Annual General Meeting, 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS

Tues., March 15.—Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, Annual General Meeting, "Class 25 Condensing Locomotives on the South African Railways—Design and Operating Experiences," R. Roosen, 5.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS

To-day, March 11.—WESTERN BRANCH: Technical College, Gloucester, "Powder Metallurgy Applications," B. H. Swan, 7.30 p.m.

Sat., March 12.—SOUTHERN BRANCH: Visit to the works of J. and E. Hall, Ltd., Dartford, 9 a.m. ★ SOUTHERN GRADUATES' SECTION: Visit to the British Internal Combustion Engine Research Establishment, Slough, Bucks, 9.30 a.m.

Tues., March 15.—S. WALES BRANCH: Kingsway Demonstration Theatre, S. Wales Electricity Board, Swansea, "Effect of Nuclear Radiation on Engineering Materials," A. H. Cottrell, 6 p.m. ★ EASTERN GRADUATES' SECTION: Visit to Building Research Station, Watford, 2 p.m. ★ MIDLAND BRANCH, RUGBY PANEL: College of Technology and Arts, Rugby, "Production, Fabrication, Properties and Uses of Some of the Newer Metals," N. P. Inglis, 6.30 p.m. ★ BIRMINGHAM A.D. CENTRE: College of Technology, Wolverhampton, "Construction and Behaviour Characteristics of Tyres," T. French, 7.30 p.m. ★ N.W. A.D. CENTRE: Crewe Arms, Crewe, "Combustion Chamber Design and the Influence of Fuel Quality," D. Downs, 7 p.m.

Wed., March 16.—AUTOMOBILE DIVISION: 1, Birdcage Walk, Westminster, London, S.W.1, "Automobile Braking," R. C. Parker, 6 p.m. ★ E. MIDLANDS BRANCH: Technical College, Scunthorpe, "Construction of the Jodrell Bank Radio Telescope," C. N. Kington, 7.30 p.m. ★ N.W. BRANCH, BLACKBURN PANEL: N.W. Electricity Board Lecture Room, Jubilee Street, Blackburn, "The Manufacture of Watches" A. W. Marshall, 7.30 p.m. ★ COVENTRY A.D. GRADUATES' SECTION: Craven Arms, High Street, Coventry, "The Control Requirements of Commercial Vehicles," D. E. Gee, 7.30 p.m. ★ N.E., A.D. CENTRE: The University, Leeds, 2, "Some Problems We Meet," L. H. Dawtrey, 7.30 p.m. ★ E. MIDLANDS GRADUATES' SECTION: College of Technology and Commerce, Leicester, "Properties of Compressible Fluid Pressure Waves," W. A. Woods, 7.15 p.m.

Thurs., March 17.—MIDLAND BRANCH: James Watt Memorial Institute, Birmingham, "Design and Construction of the Compressor for the 8ft by 8ft High-Speed Wind Tunnel at R.A.E., Bedford," L. J. Cheshire, 6 p.m. ★ N.E. BRANCH: Stephenson Building, Claremont Row, Newcastle upon Tyne, "Flash Evaporators for the Distillation of Sea-Water," A. Frankel, 6.15 p.m. ★ N.W. BRANCH, INDUSTRIAL ADMINISTRATION AND ENGINEERING PRODUCTION GROUP: Engineers' Club, Albert Square, Manchester, "Drop-Forging Die Design," 6.45 p.m. ★ SOUTHERN BRANCH: Stage Hotel, Dover, "Marine Refrigeration," H. R. Howells, 7.30 p.m.

INSTITUTION OF MINING AND METALLURGY

Thurs., March 17.—Geological Society, Burlington House, Piccadilly, London, W.1, "Copper Matte Smelting: The Influence of Charge Composition upon Heat Requirement," G. L. Evans, "Factors Affecting Copper Reverberatory Furnace Performances and their Influence on the Choice of Various Smelting Methods," L. R. Verney, 5 p.m.

INSTITUTION OF PLANT ENGINEERS

Mon., March 14.—MERSEYSIDE AND N. WALES BRANCH: Exchange Hotel, Liverpool, Annual General Meeting, followed by a film "Tubular Engineering," 7.15 p.m.

Wed., March 16.—KENT BRANCH: Kings Head Hotel, High Street, Rochester, "Power from Nuclear Energy," M. D. Wood, 7 p.m.

Thurs., March 17.—BLACKBURN BRANCH: Castle Hotel, Blackburn, Annual General Meeting, 7.30 p.m. ★ PETERBOROUGH BRANCH: White Lion Hotel, Church Street, Peterborough, Annual General Meeting, 7.30 p.m.

Fri., March 18.—BIRMINGHAM BRANCH: Imperial Hotel, Temple Street, Birmingham, Annual General Meeting followed by a film, 7.30 p.m.

INSTITUTION OF PUBLIC HEALTH ENGINEERS

Thurs., March 17.—Caxton Hall, Westminster, London, S.W.1, "Some Disjointed Notes on Trade Effluents," M. Lovett, 6 p.m.

INSTITUTION OF STRUCTURAL ENGINEERS

To-day, March 11.—S.W. SECTION: Duke of Cornwall Hotel, Plymouth, "The New Queen Elizabeth Dock at Falmouth," J. D. Norfolk, 6 p.m.

Tues., March 15.—SCOTTISH BRANCH: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Piling in Structural Engineering," W. G. N. Geddes, 7 p.m.

Wed., March 16.—JOINT MEETING WITH THE REINFORCED CONCRETE ASSOCIATION: 11, Upper Belgrave Street, London, S.W.1, "A Further Report on the Work of the European Committee on Concrete," A. L. L. Baker, 6 p.m. ★ YORKSHIRE BRANCH, JOINT MEETING: Metropole Hotel, Leeds, "Research and its Application to Road Construction," J. M. Fisher, A. R. Lee and R. S. Millard, 6.30 p.m.

Fri., March 18.—LANCASHIRE AND CHESHIRE BRANCH: College of Science and Technology, Manchester, "The Design and Construction of the Exhibition Palace of the National Centre of Industries and Technology, Paris," D. D. Mathews, 6.30 p.m. ★ N. COUNTIES BRANCH: Neville Hall, Newcastle, "The Modernisation of British Waterways with particular reference to the South Eastern Division," J. H. H. Gillespie, 6.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS

To-day, March 11.—Pepys House, 14, Rochester, Row, Westminster, London, S.W.1, "Refrigeration at Sea," D. W. Higham, 7 p.m. ★ N.W. SECTION: Engineers' Club, Albert Square, Manchester, Election of Officers and Film Evening, 7.30 p.m.

Mon., March 14.—SHEFFIELD SECTION: Livesey Clegg House, 44, Union Street, Sheffield, 1, "Electrostatic Precipitators," B. J. Duncan, 7.30 p.m.

Fri., March 18.—INFORMAL MEETING: Pepys House, 14, Rochester Row, Westminster, London, S.W.1, "Application, Uses, and Limitations of Modern Plastics Materials in Engineering," J. M. J. Estevez, 7 p.m.

N.E. COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS

Mon., March 14.—Mining Institute, Newcastle upon Tyne, "An Analysis of Recent Screwshaft Casualties" H. N. Pemberton and G. P. Smedley, 6.15 p.m.

PLASTICS INSTITUTE

Fri., March 18.—MIDLANDS SECTION: James Watt Memorial Institute, Great Charles Street, Birmingham, "Silicones in the Plastics and Rubber Industries," P. A. J. Gate, 6.30 p.m.

REINFORCED CONCRETE ASSOCIATION

Tues., March 15.—SCOTTISH BRANCH: North British Hotel, Edinburgh, "The Forth Road Bridge," J. A. K. Hamilton, 6.30 p.m.

Wed., March 16.—11, Upper Belgrave Street, London, S.W.1, "A Further Report on the Work of the European Committee on Concrete," A. L. L. Baker, 6 p.m.

ROYAL AERONAUTICAL SOCIETY

Tues., March 15.—Library, 4, Hamilton Place, London, W.1, "Some Problems of Separated and Vortex Flow," H. B. Squire, 7 p.m.

Thurs., March 17.—MAIN LECTURE: Institution of Mechanical Engineers, 1, Birdcage Walk, Westminster, London, S.W.1, "Supersonic Aircraft—Promise and Problems," M. E. Morgan, 6 p.m.

Fri., March 18.—AGRICULTURAL AVIATION GROUP: Library, 4, Hamilton Place, London, W.1, Film Evening, 7 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN

Fri., March 18.—21, Albemarle Street, London, W.1, "Infra-Red Radiation," R. V. Jones, 9 p.m.

ROYAL STATISTICAL SOCIETY

Thurs., March 17.—BRISTOL GROUP: Library Room, The University, Bristol, "Short Cut Approximate Methods in Statistical Analysis," P. G. Moore, 5.45 p.m.

SOCIETY OF CHEMICAL INDUSTRY

Wed., March 16.—CORROSION GROUP: 14, Belgrave Square, London, S.W.1, "The Mechanism of Inhibition in Neutral Aqueous Solutions," D. M. Brasher, 6 p.m.

SOCIETY OF INSTRUMENT TECHNOLOGY

Wed., March 16.—CONTROL SECTION: Manson House, 26, Portland Place, London, W.1, "The Simulation of a Large Chemical Plant on an Electronic Analogue Computer," A. H. Doveton, 6.30 p.m.

SOCIETY FOR WATER TREATMENT AND EXAMINATION

To-day, March 11.—Library, Royal Society of Health, 90, Buckingham Palace Road, London, S.W.1, Annual General Meeting: Symposium on "Pollution of Surface Water Supplies," 9.30 a.m.

SOUTH WALES INSTITUTE OF ENGINEERS

Thurs., March 17.—Park Place, Cardiff, "Large Diameter Boreholes for Ventilation and Staple Shaft Sinking," J. H. Pedley, 6 p.m.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE

Fri., March 18.—39, Elmbank Crescent, Glasgow, "Technical Factors in the Production of Iron by Methods other than the Blast Furnace," J. Taylor, 6.45 p.m.

WOMEN'S ENGINEERING SOCIETY

Wed., March 16.—LONDON BRANCH: Hope House, 45, Great Peter Street, Westminster, S.W.1, Members' Evening, 7 p.m.

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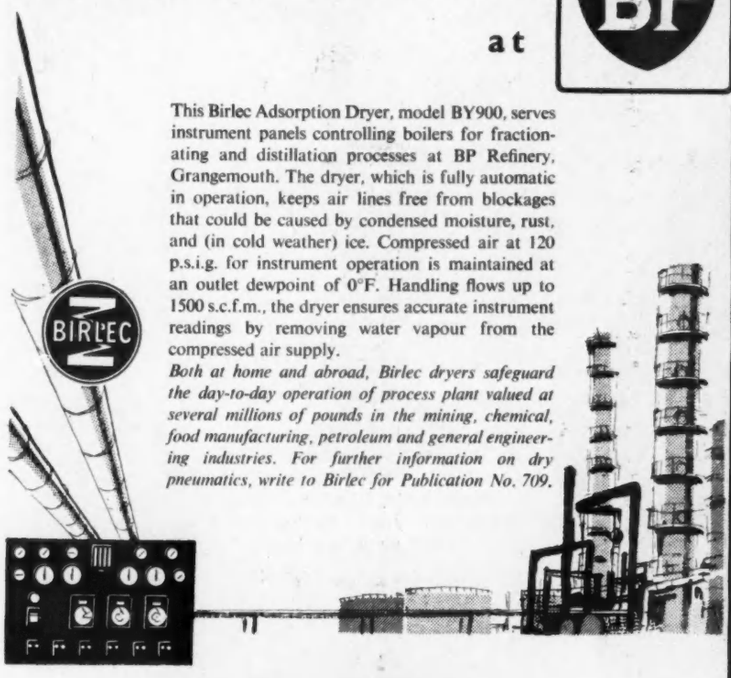

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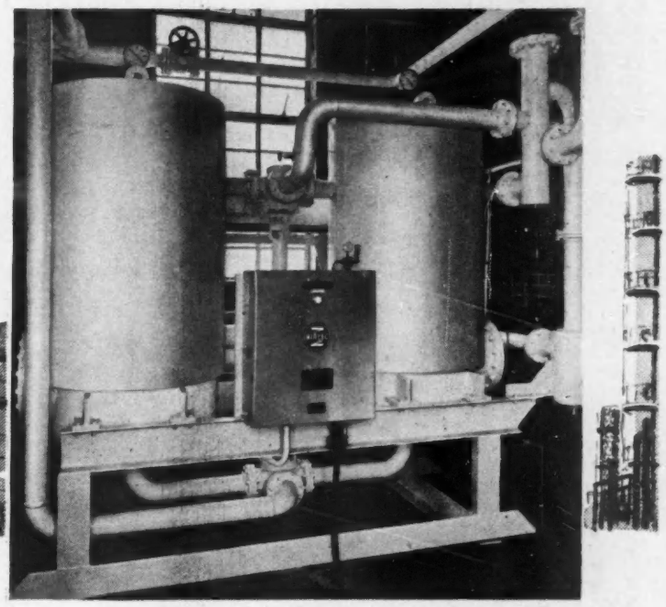

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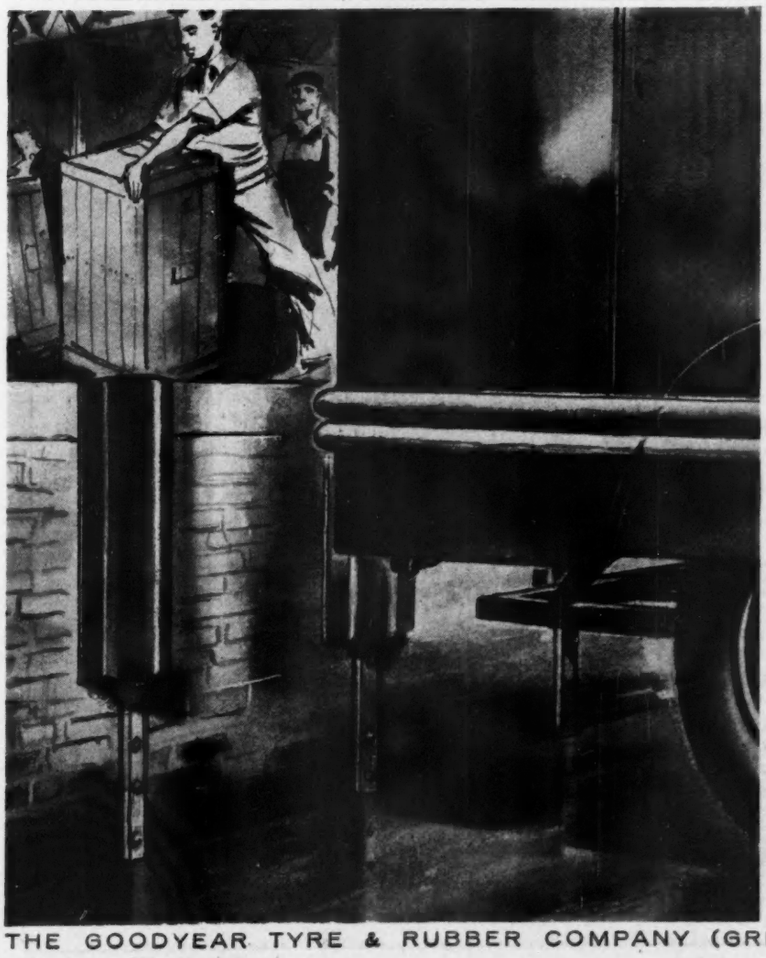

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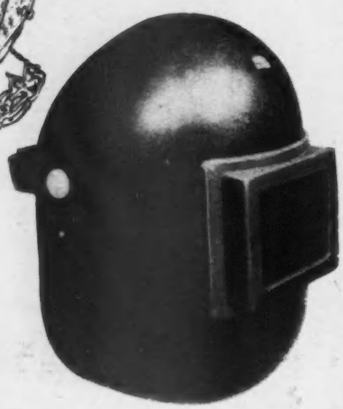

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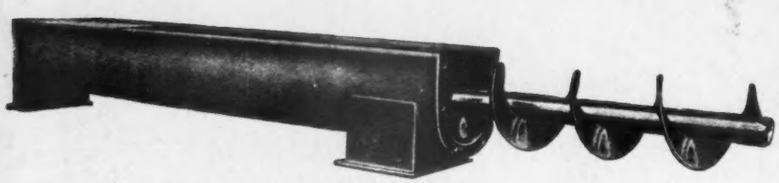

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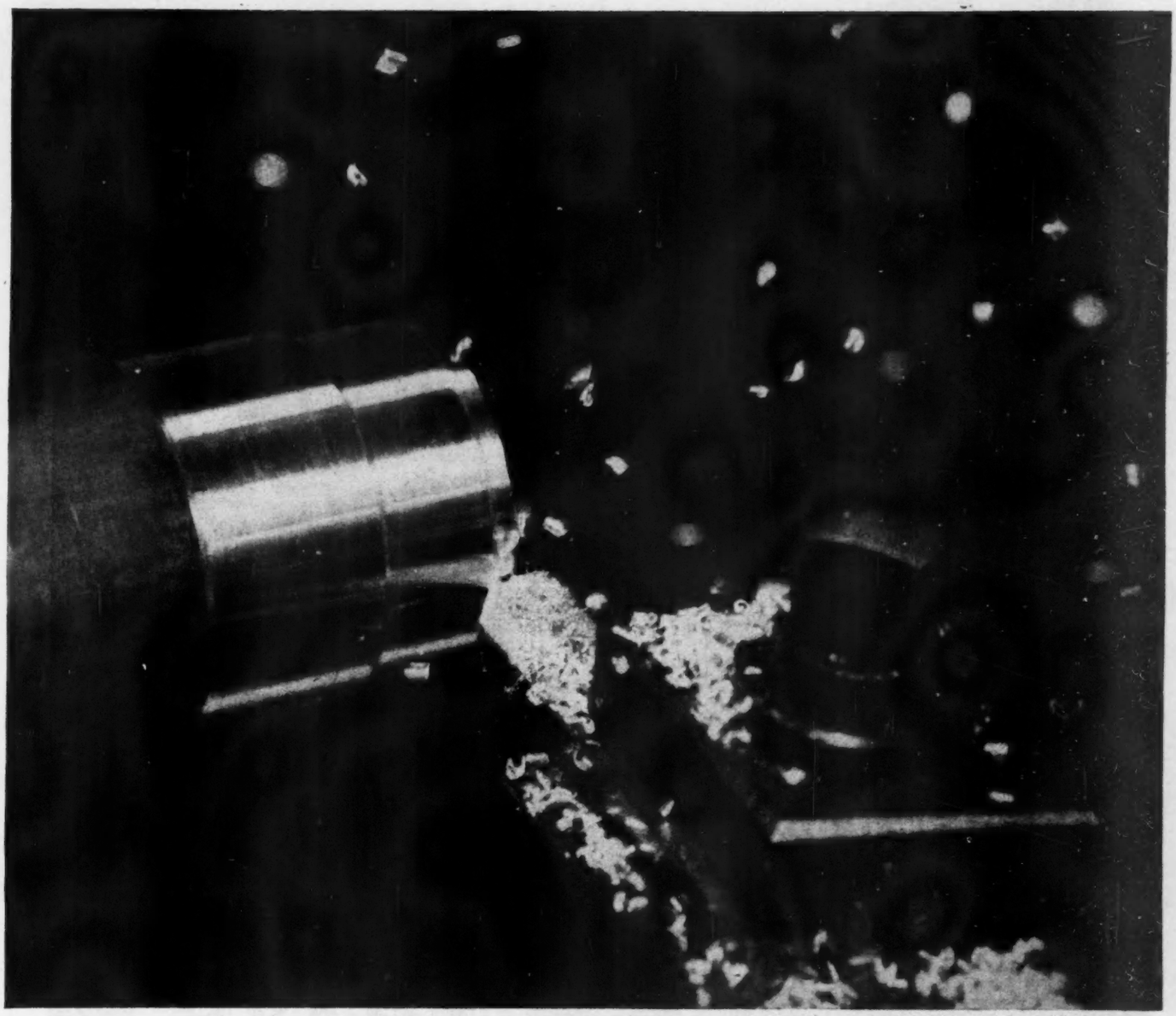

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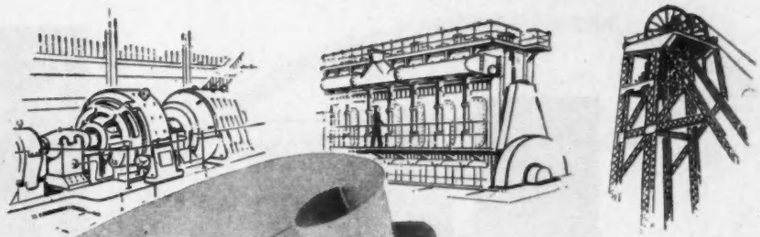

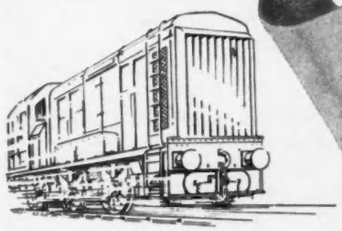

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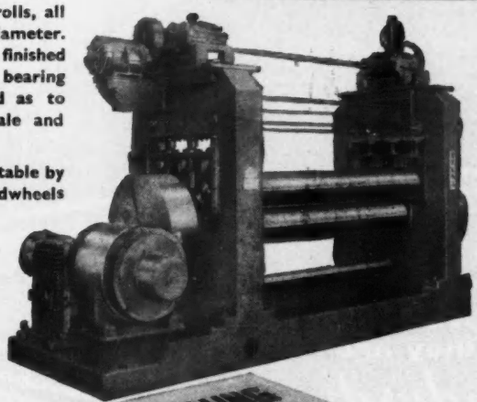

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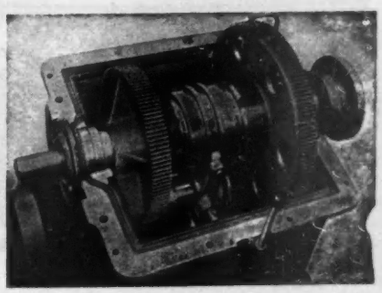

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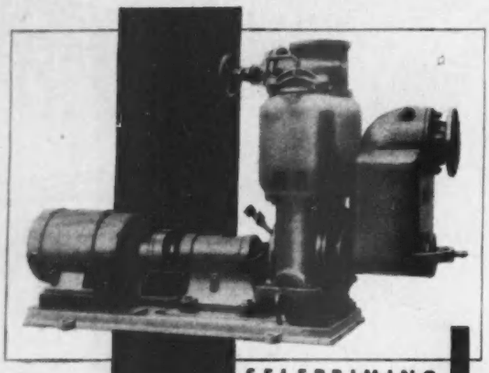

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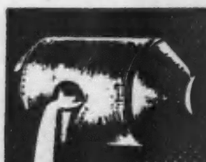

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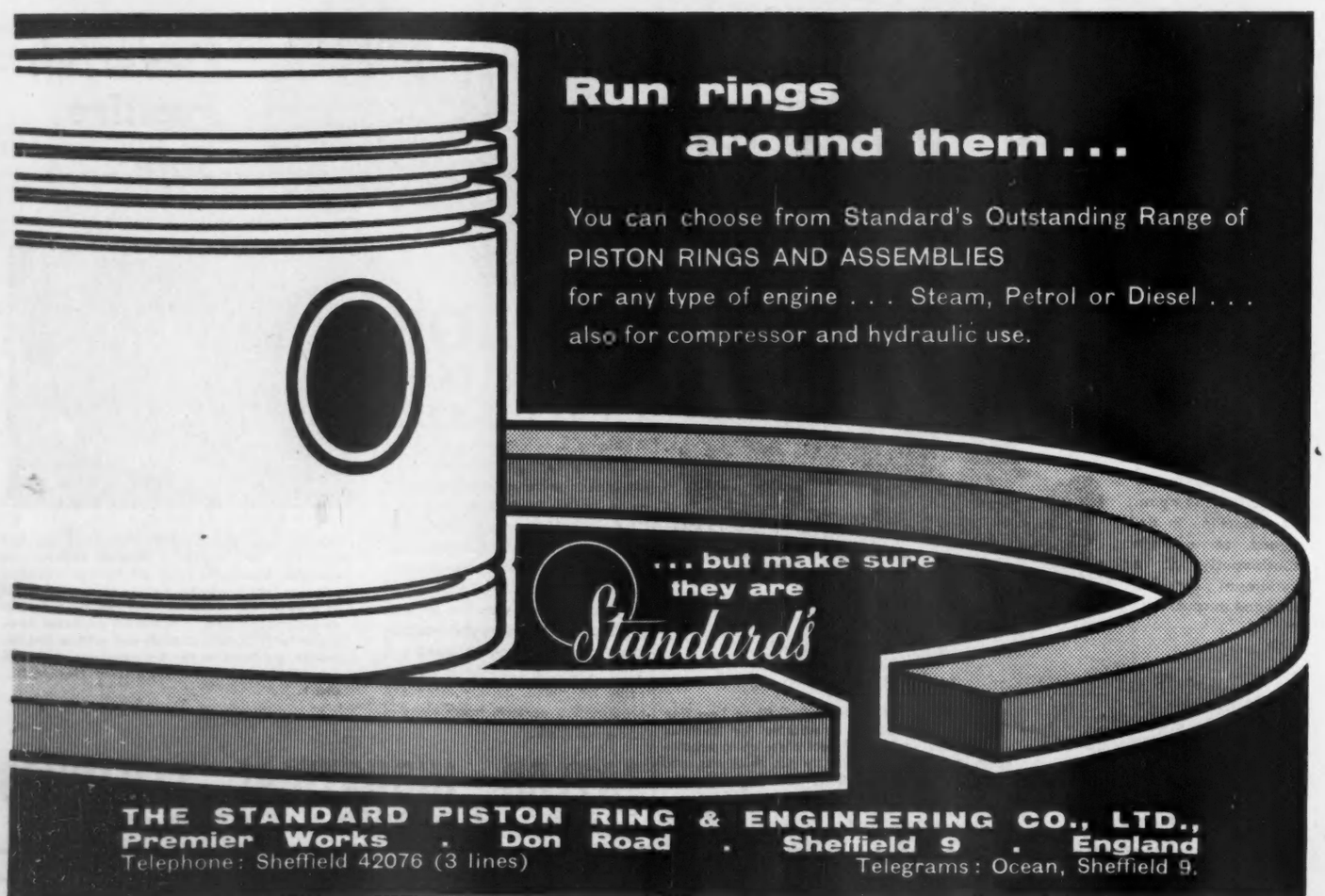

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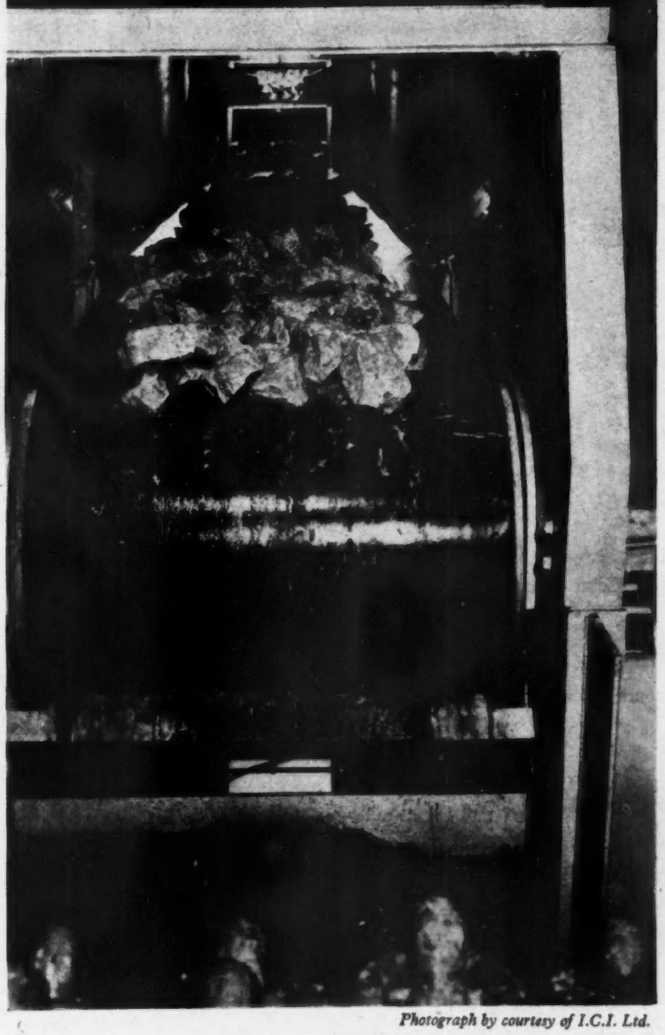

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From the left...Number!

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2 **expanded for anti-corrosion grills**
3 **tubing for corrosive fluids**
4 **rod for chemical plant**
5 **extruded glazing strip**
6 **welding rod for fabricating Cobex**
7 **Cobex/Velbex laminates for toughness**
8 **opaque lamination with expanded metal for cowlings**
9 **corrugated for roof lights etc.**
10 **thick chemical grade sheet**
11 **Cobex/expanded metal laminate for higher temperature**
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14 **opaque sheet for display and general forming**
15 **corrugated translucent white sheeting for lighting**

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THE PRESS.

1200 ton "British Canning" Press under construction.
(This mass of metal weighs about 165 tons!)
The press is completely automatic in operation & all its parts are made here, including "Dies".

"There are two lines of crane runways. A slag 60 tonner below & this 'high flier' way up in the roof.

Height, about 3 feet above ground, and at least 10 feet below ground.

Five hundred men work in this shop, when not in use, the floor is covered with timber platforms.

Eccentric Gear
Steel casting also made here. 1½ tons

These are Tom's "Sluiger."

This is the long shaft that transmits power from the drive shaft to the moving parts of the press. It is installed eight feet below the surface.

Tom Dodds, "Sluiger" of 17 shop.
An important man indeed. His job is to load, and control all movements of the great cranes. A great deal depends on his nerve, skill and judgement. He's a Vickers typical all right. His father was a crane driver here, & Tom has a son in the Research dept.

The shop is about ¼ mile long and 70 feet high, and there are huge forges other than this.

The shop cat, that everybody feeds but nobody owns!

Mr. Terence Cuneo has been commissioned by Vickers Limited to produce a series of drawings giving his impressions of the immense resources and production capacities of the Vickers Group. Mr. Cuneo's original pencil sketch and notes for his subject, made on the spot and reproduced here, convey in a particularly vivid manner the size and capabilities of the Newcastle shops.

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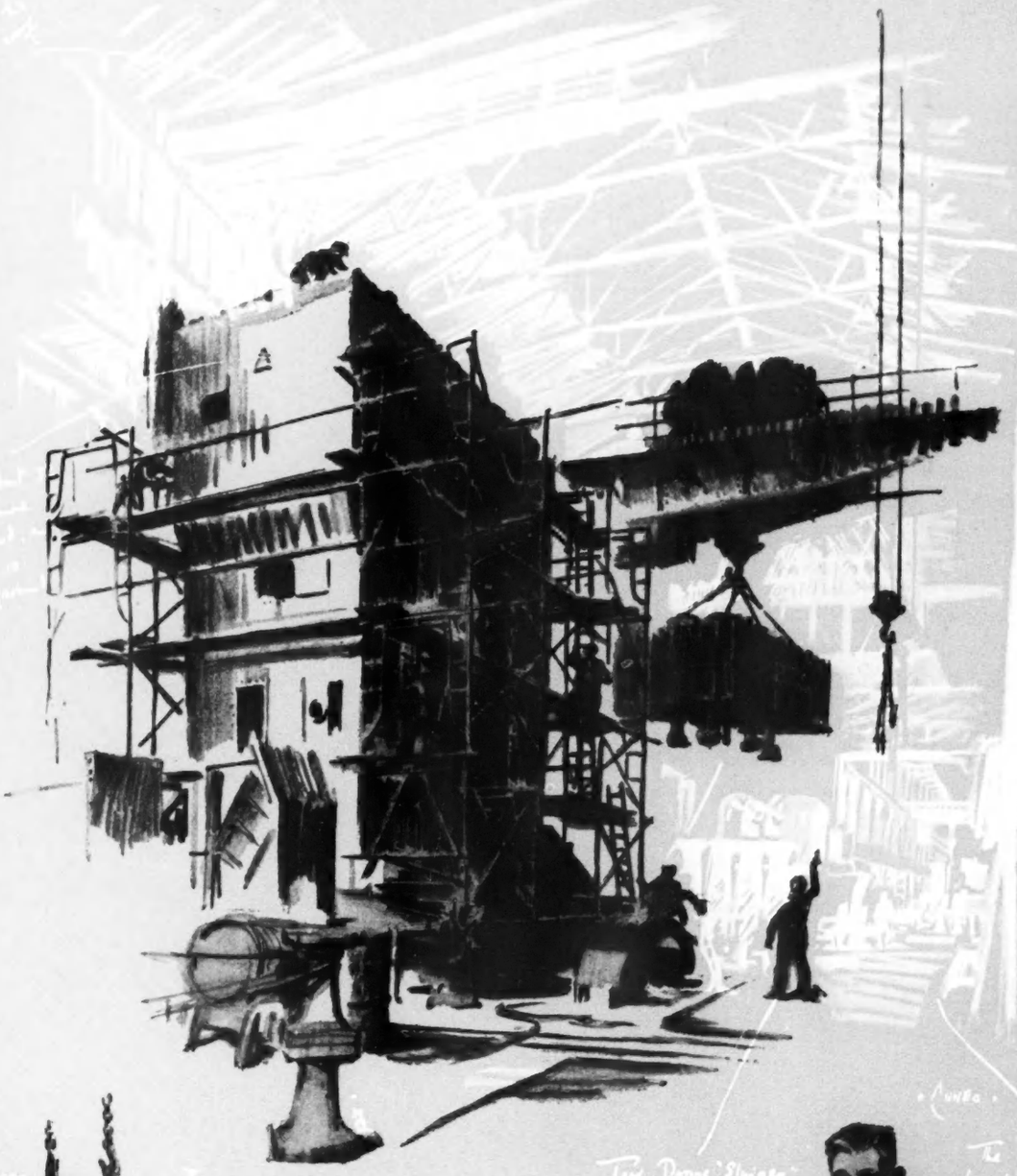

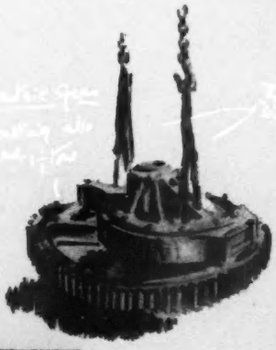

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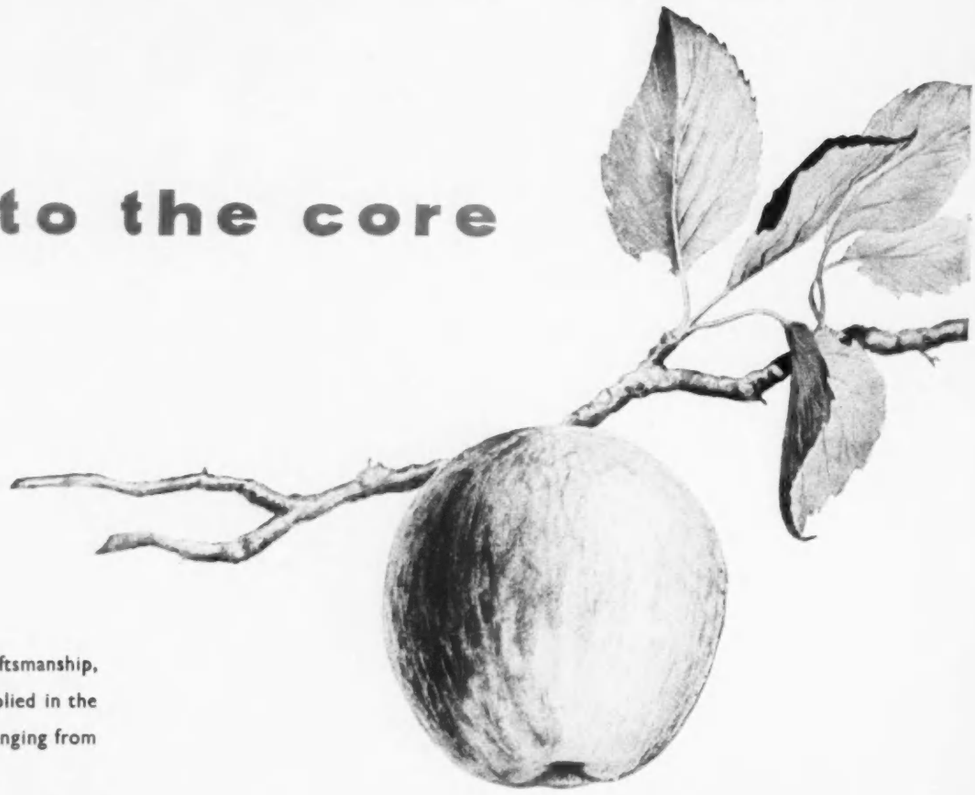
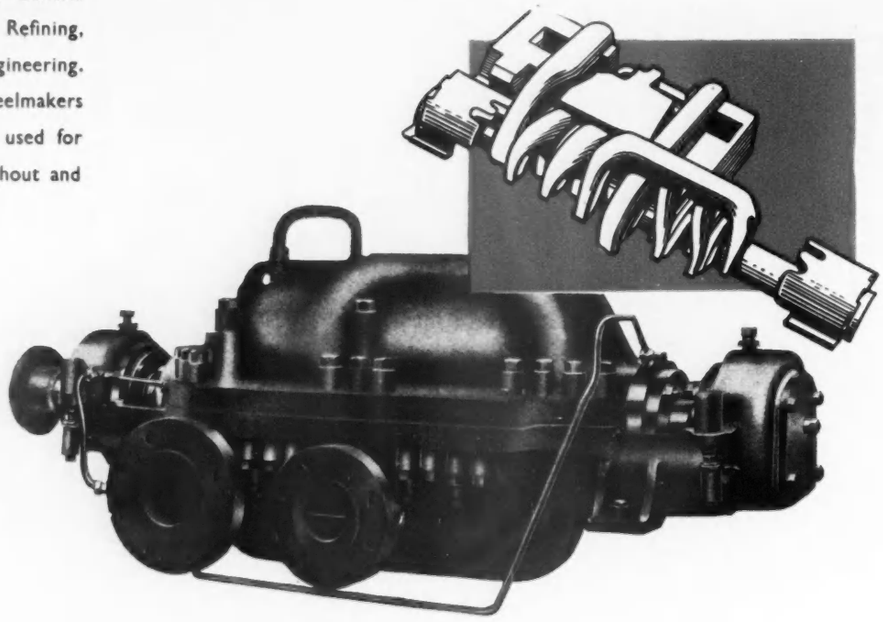
Sound to the core



Modern steel-founding is a blend of craftsmanship, art and technology, all of which are applied in the Osborn foundries to produce castings ranging from a few pounds to several tons in weight.

Castings in carbon and alloy steels are manufactured for many industries including General Engineering, Mining, Quarrying, Oil Refining, Dredging, Chemical and Electrical Engineering. The Company's reputation as steelmakers ensures that only the finest steels are used for these castings, which are sound throughout and of the ultimate standard of quality.



Osborn castings are used in this *Hayward Tyler - Byron Jackson six stage 'Multiplex' pump.* Inset illustrates core used for casting the upper half of casing.

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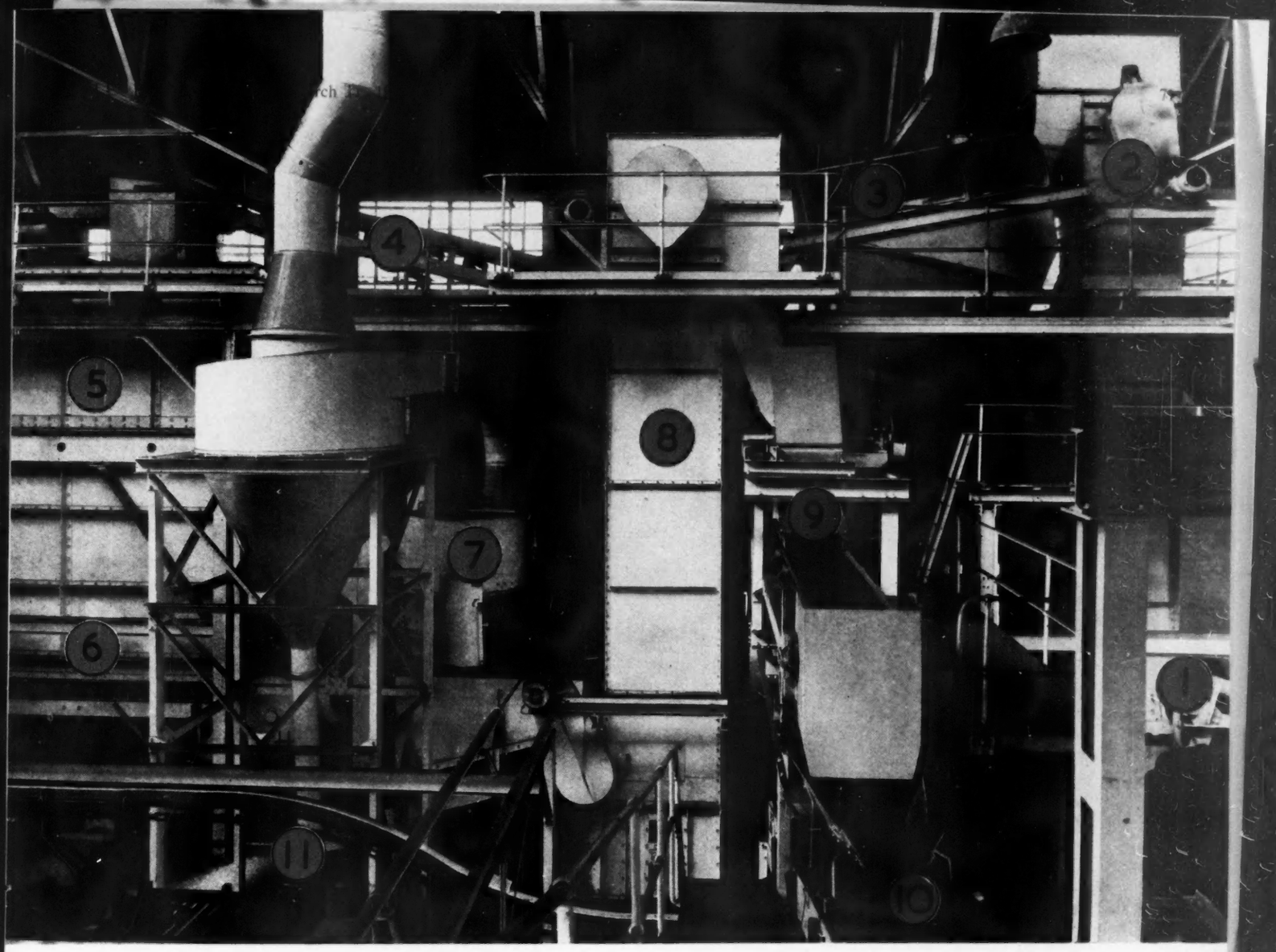

The illustration shows that part of a **MORRIS** foundry sand and mechanization plant which reconditions knocked-out sand. At **1**, sand coming from the knock-out via an apron plate and belt conveyor passes beneath a magnetic separator (to remove tramp iron) and falls into the boot of a belt-bucket elevator **2**, discharging into screen **3** onto belt conveyor **4**, which in turn discharges into sixty-ton storage hopper **5**. The flat belt conveyor **6**, under the hopper, pours sand into the skip which feeds the mulling machine (known as the Speedmullor). This machine **7**, providing a rapid mulling cycle with close batch control, discharges the sand into belt-bucket elevator **8**. From thence, the sand proceeds via belt conveyors **9** and **10** to the moulders. The overhead chain conveyor **11** serves the core shop with sand and also takes the cores to the stoves and to the moulders.

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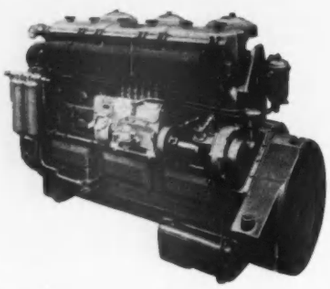
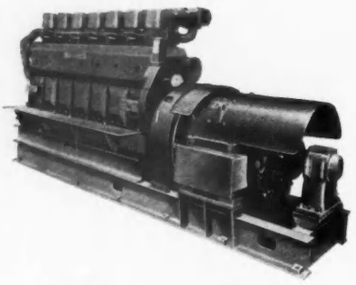


LE6 diesel engine 130/185 b.h.p. at 1200/1800 r.p.m.



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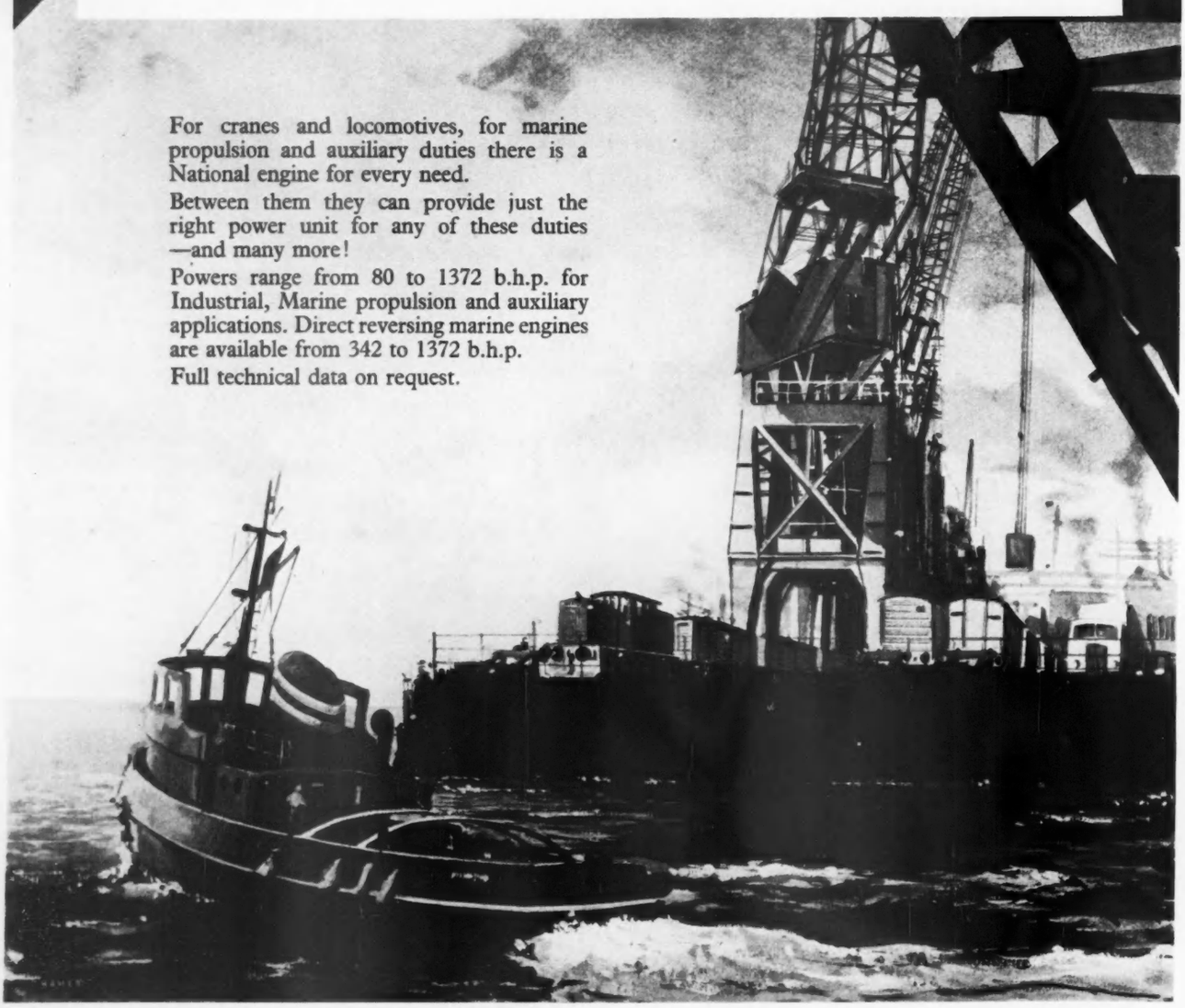

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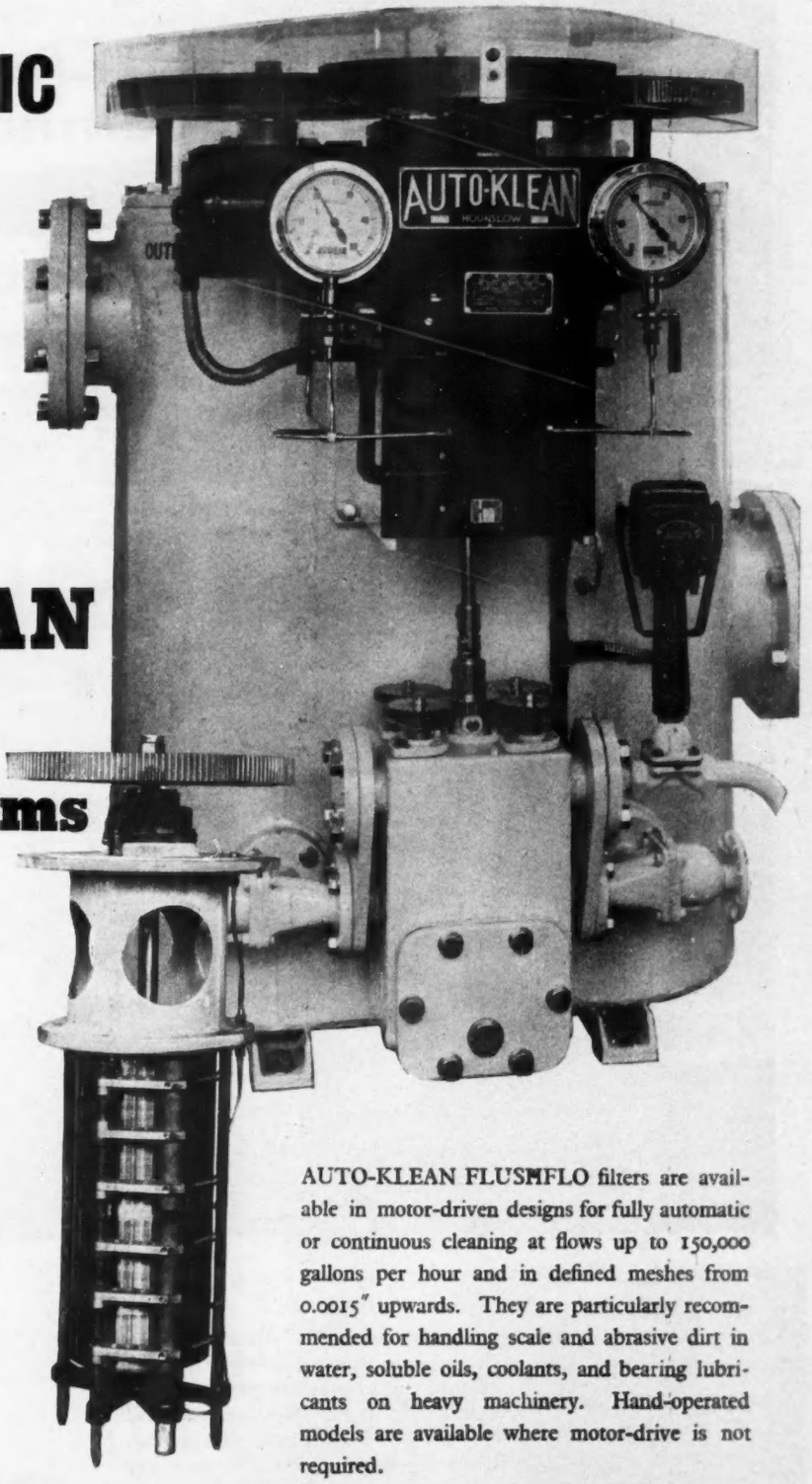

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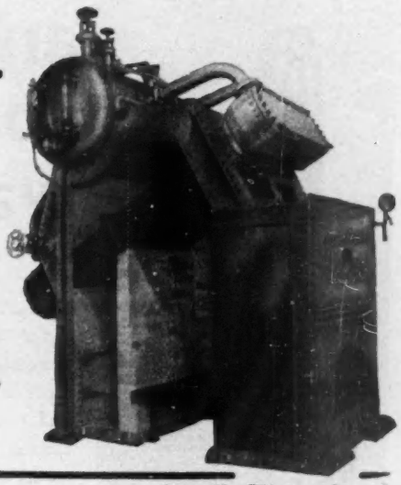

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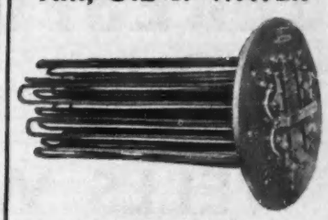

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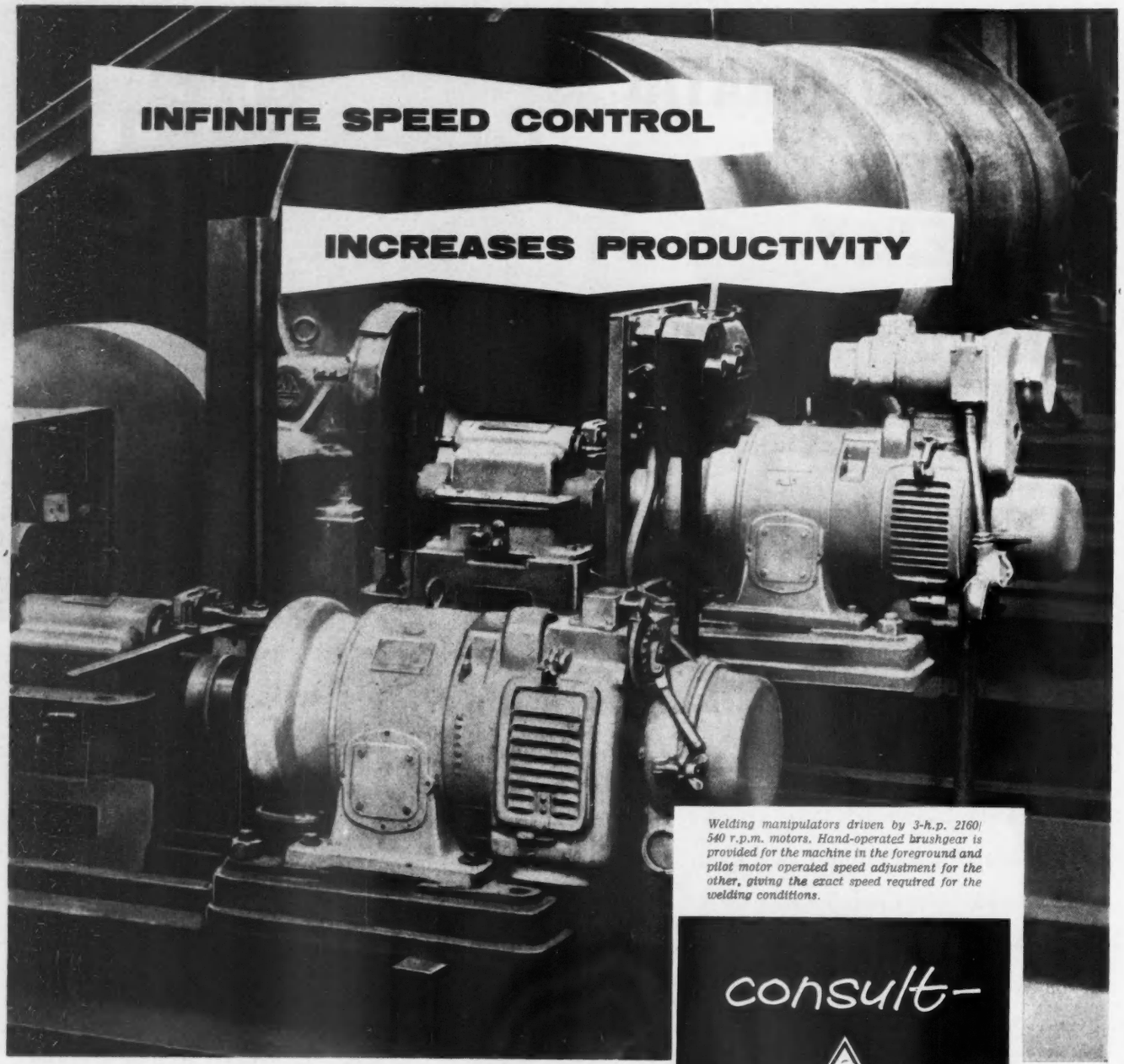

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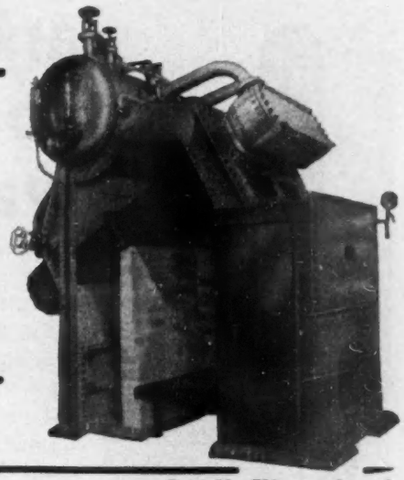

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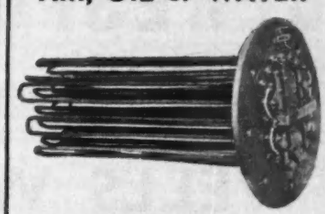

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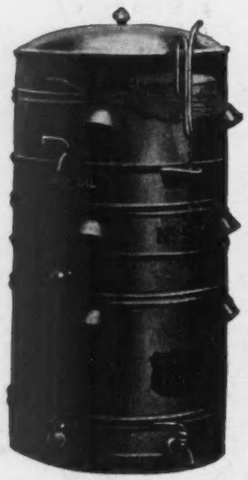

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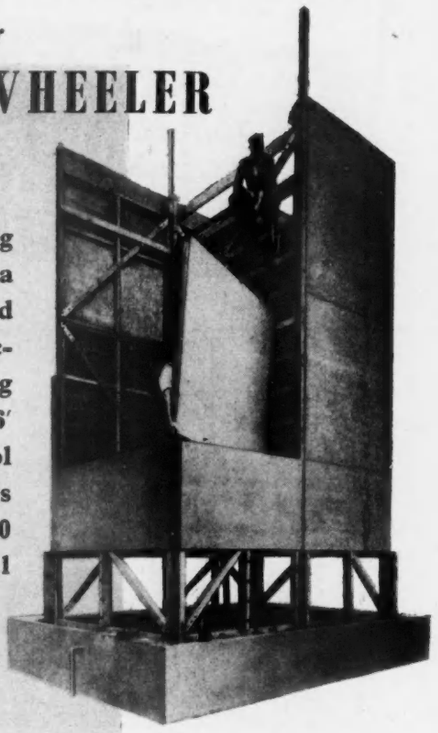

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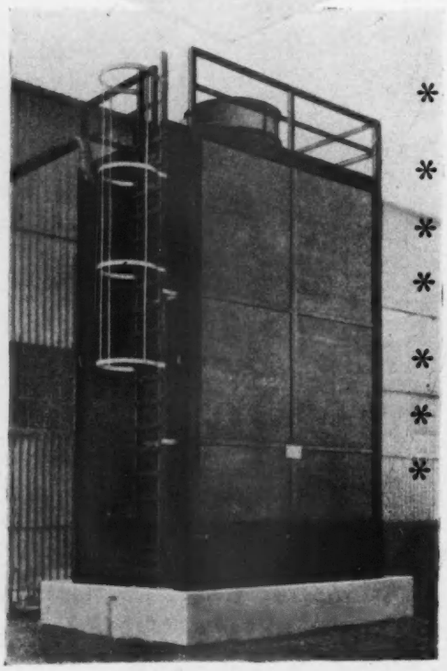

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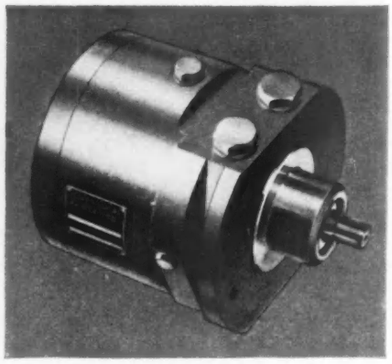

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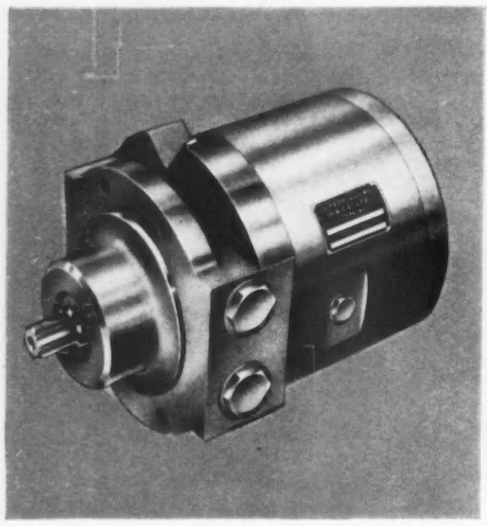

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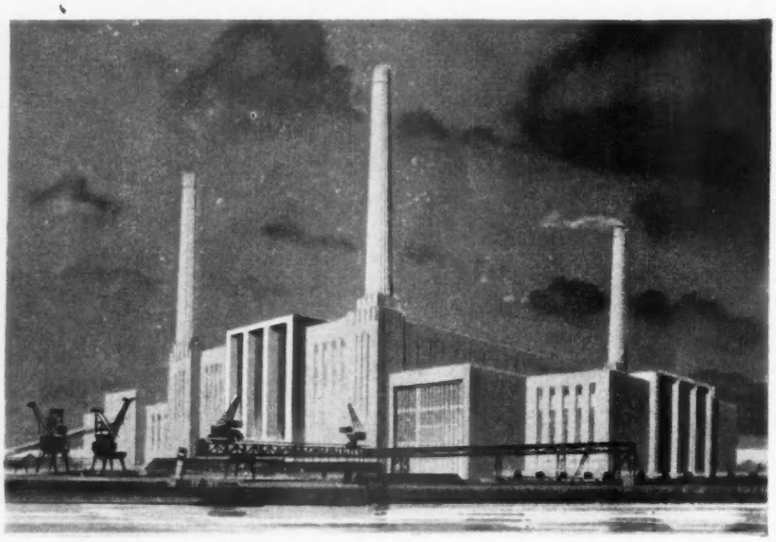

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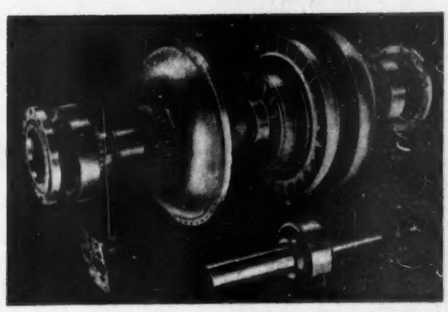

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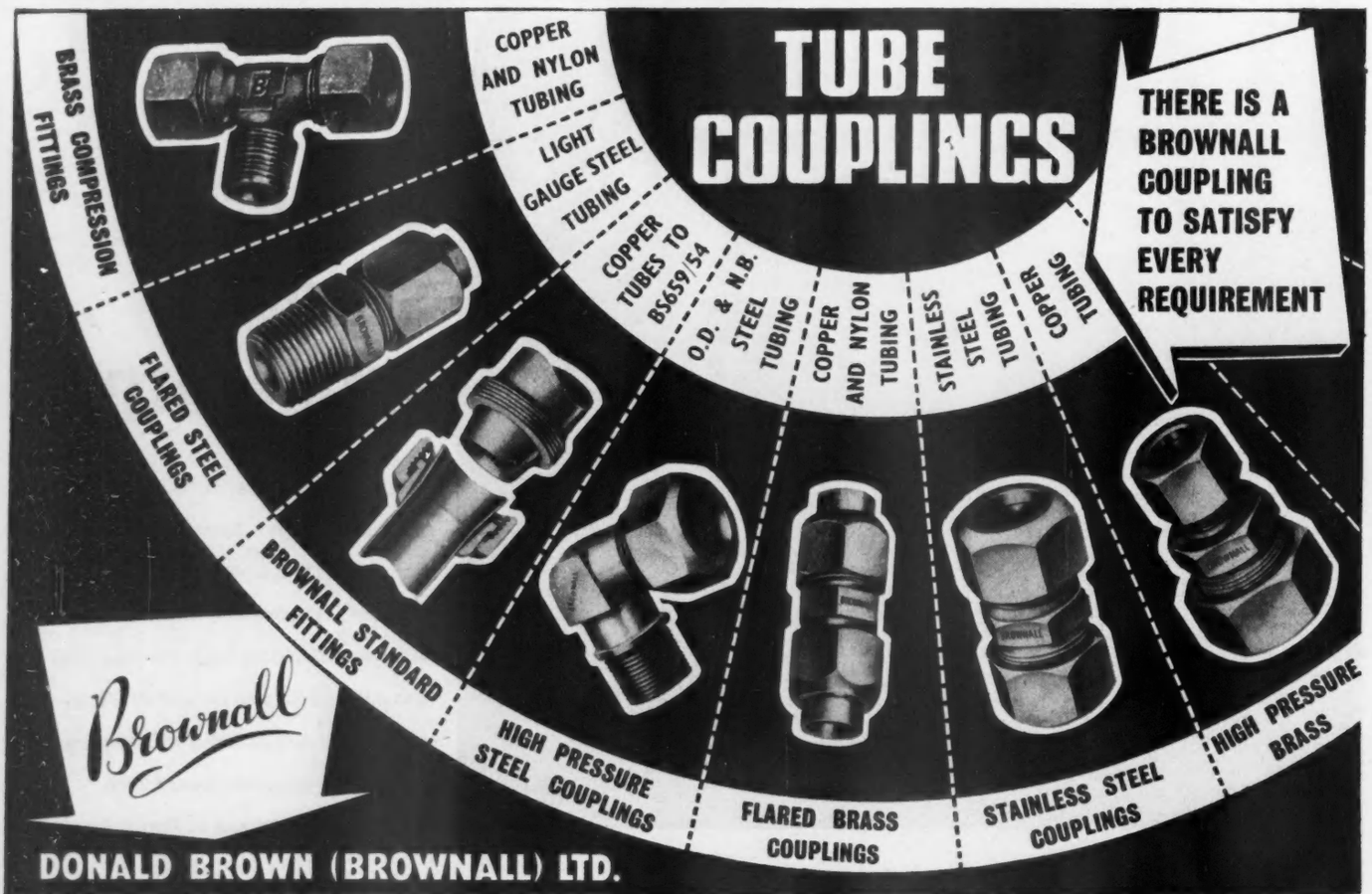

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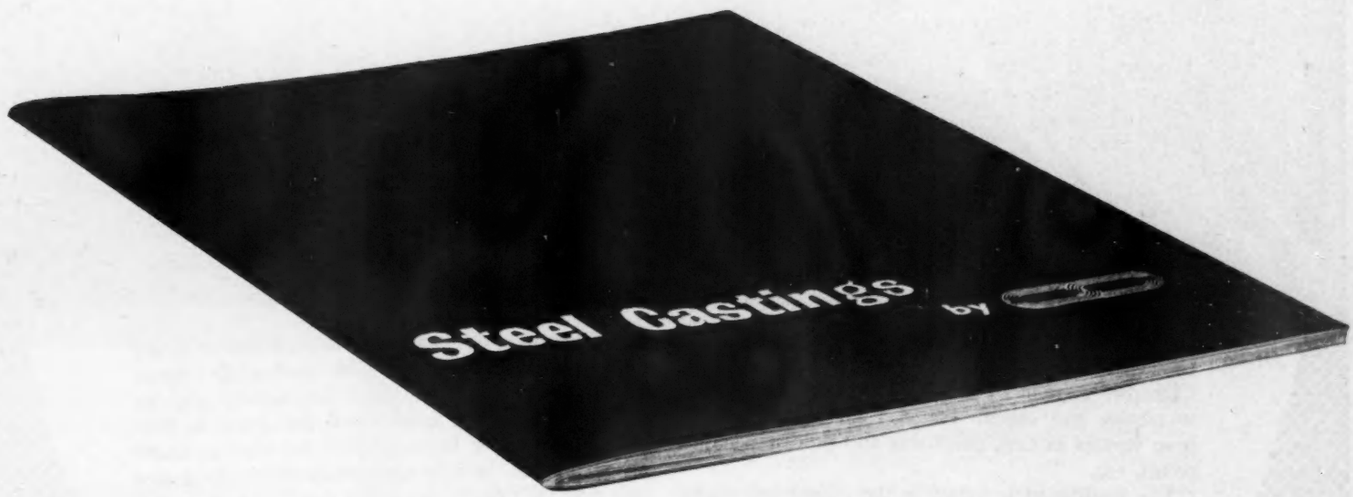

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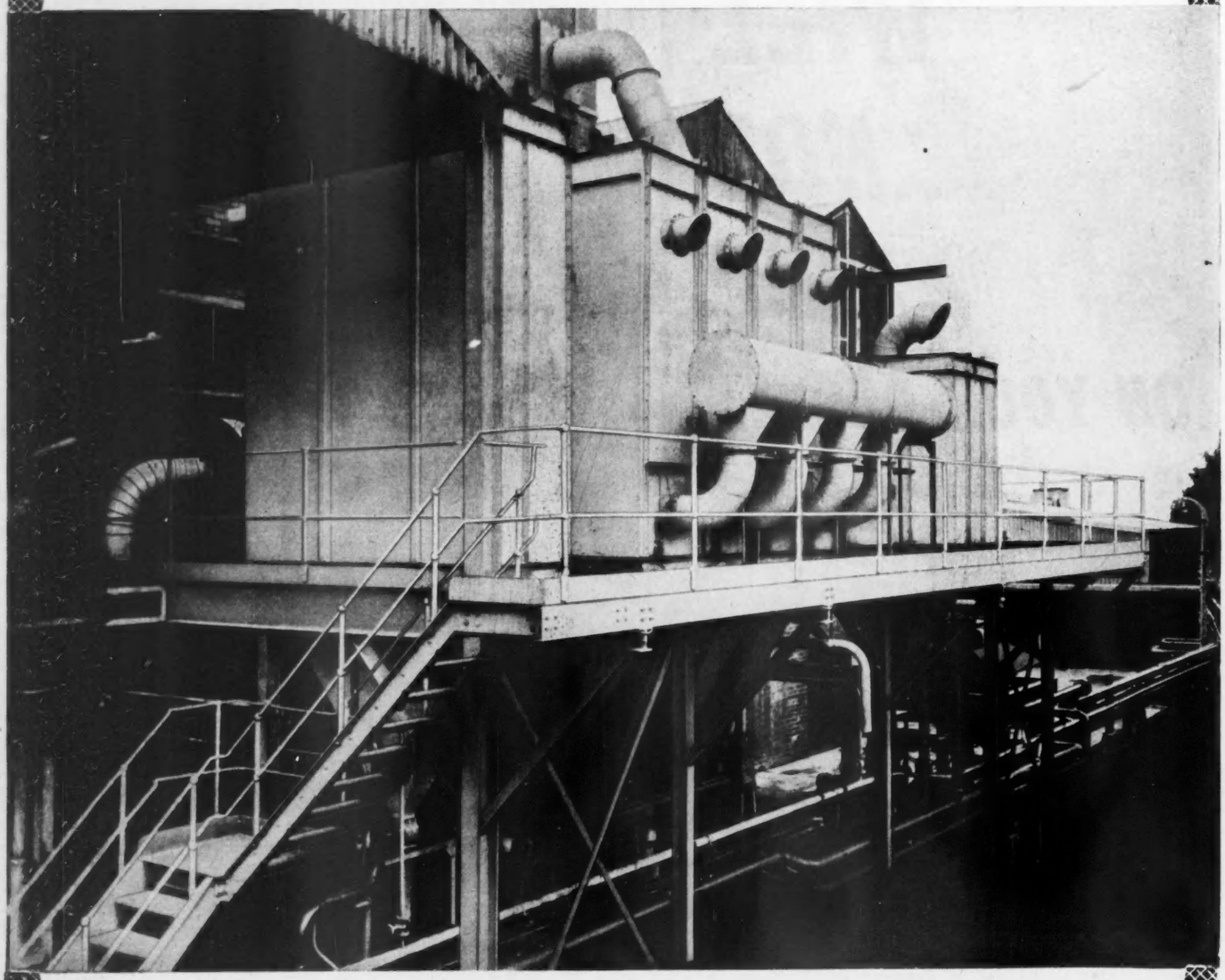

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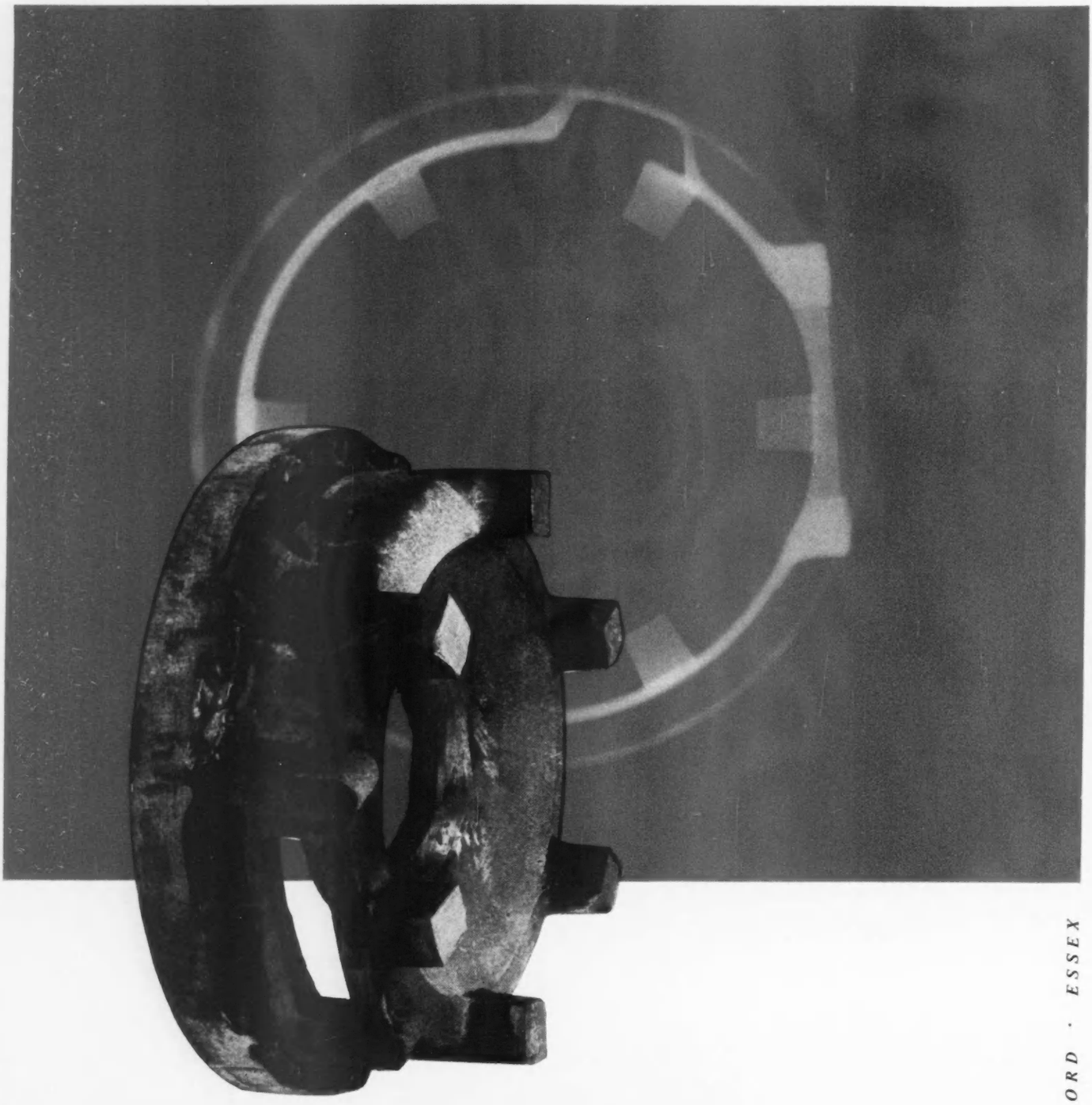

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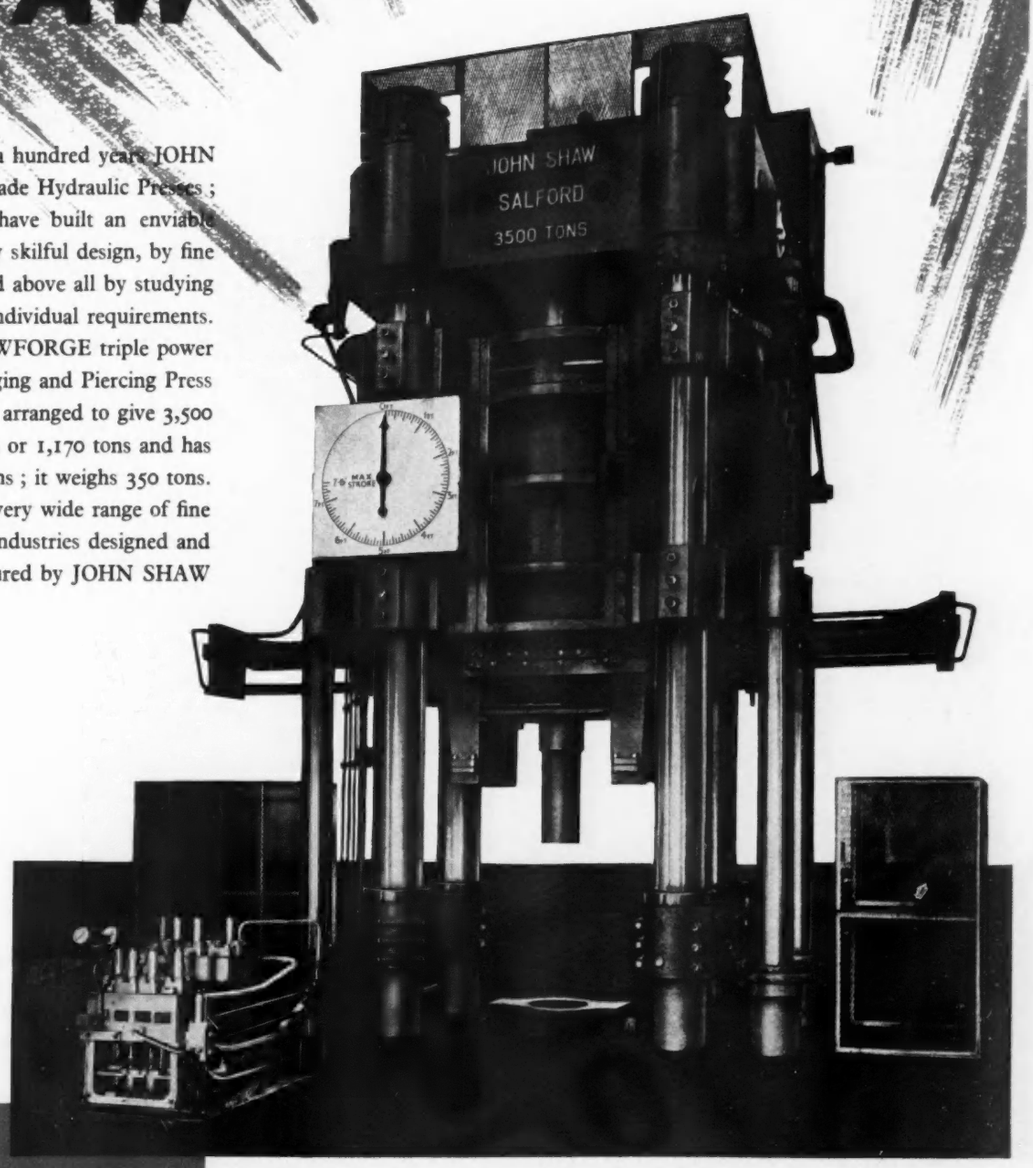

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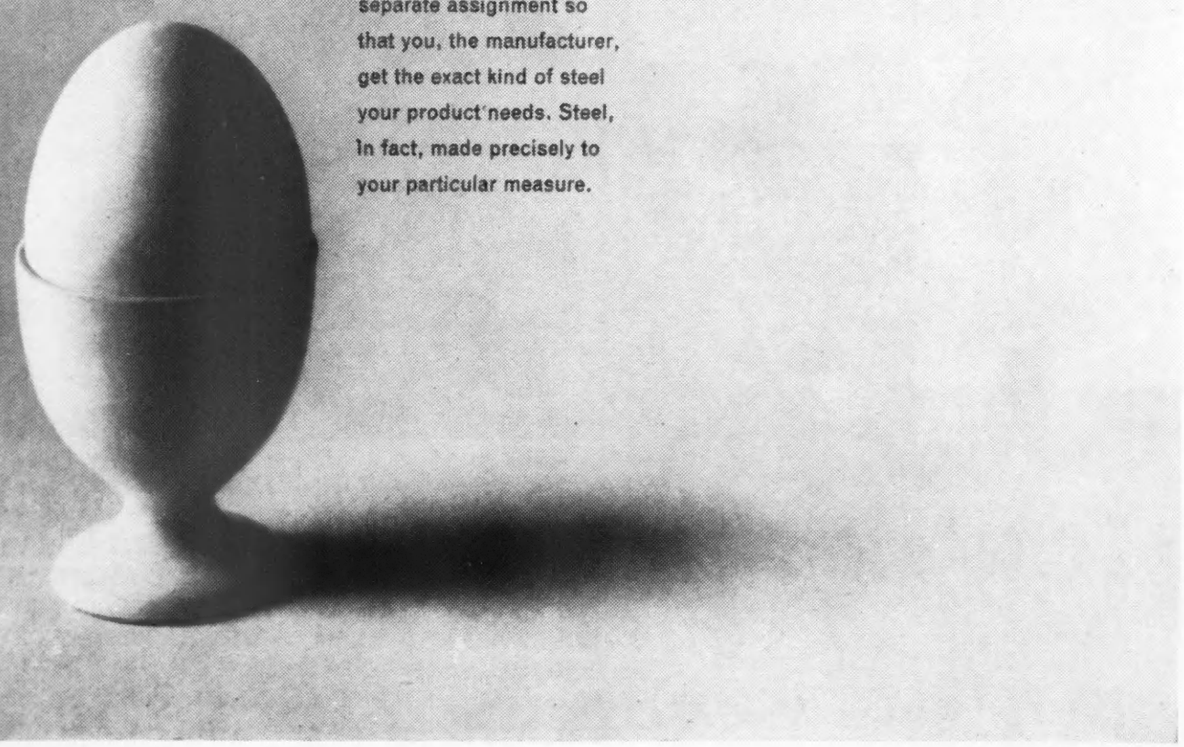

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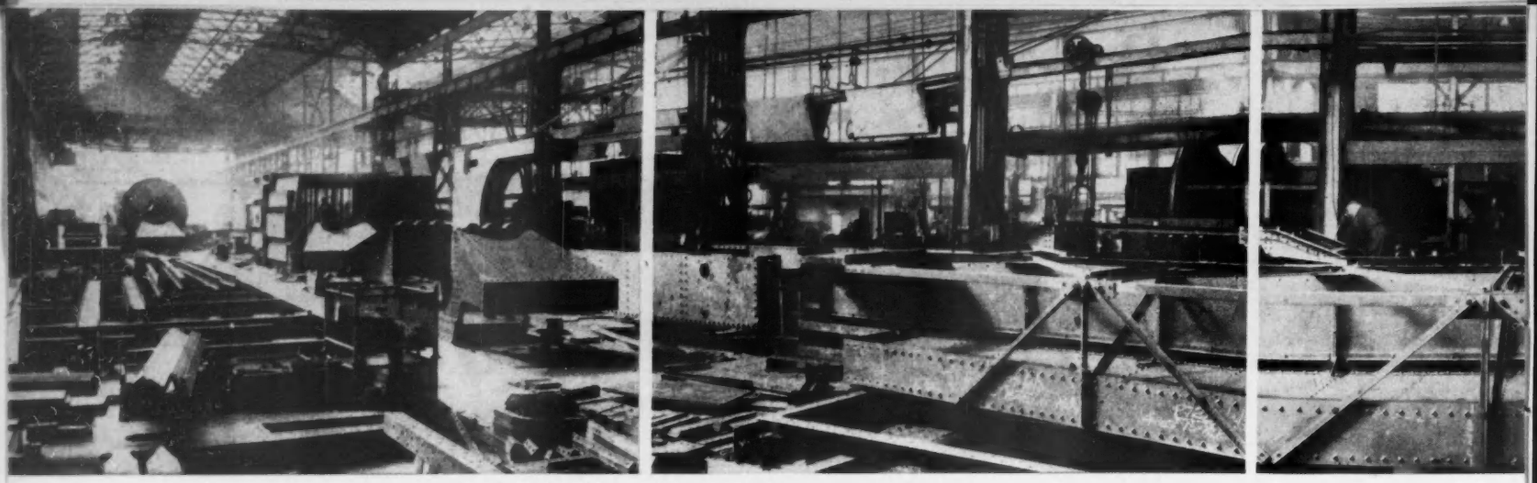

Panoramic view of the extended constructional shops

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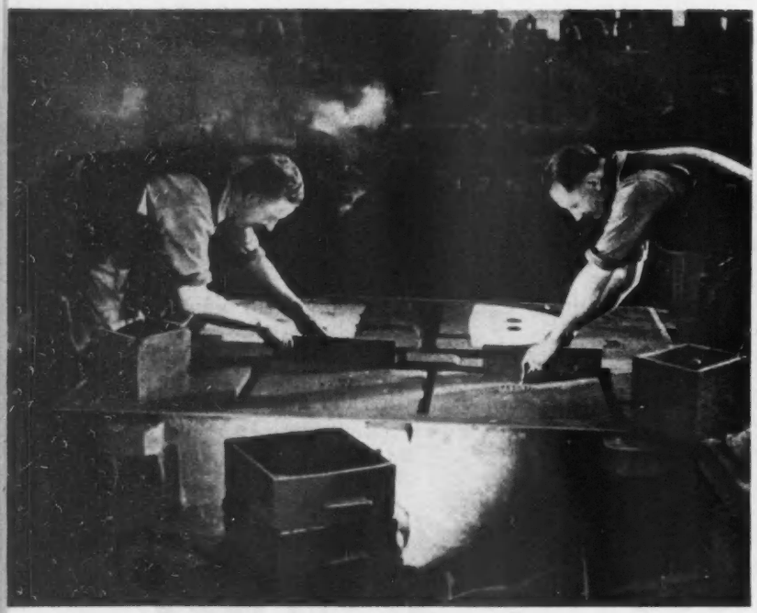
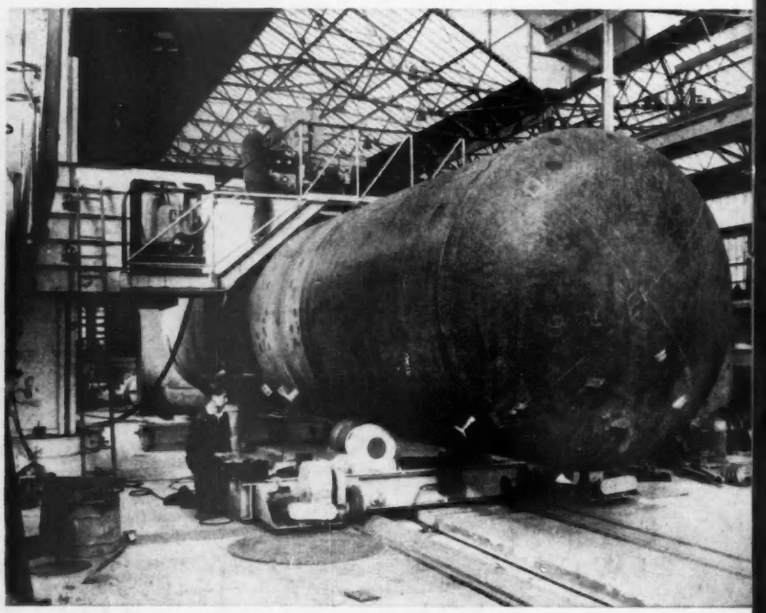
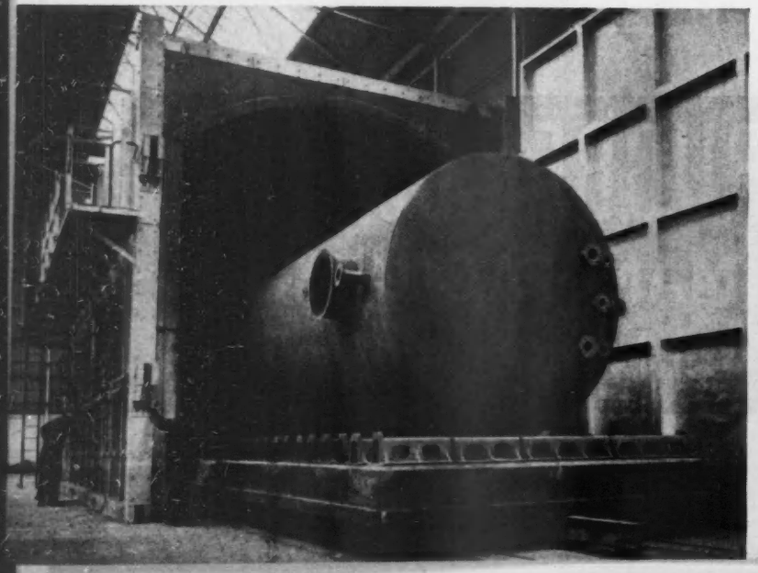


Preparing to cast in Meehanite metal in the foundries.

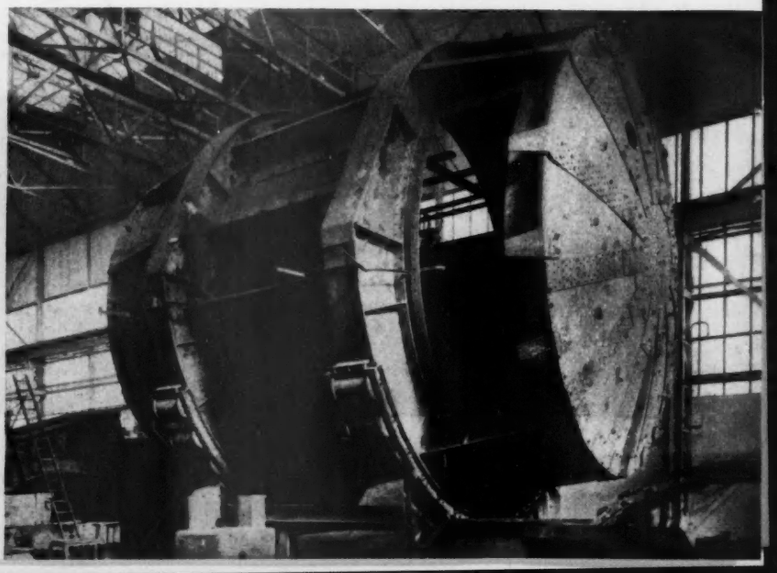


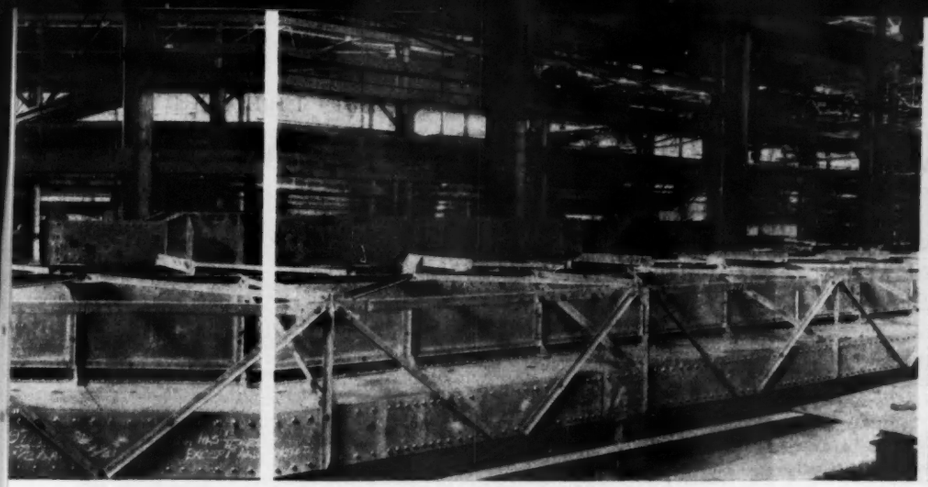
Automatic welding of a large pressure vessel.

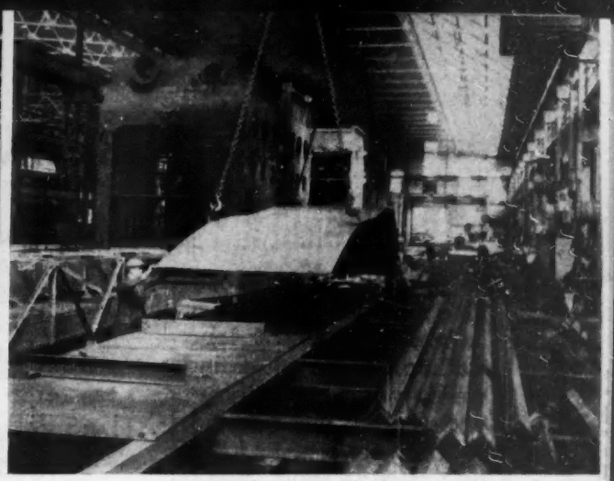
The large new stress relieving furnace in use.



Hot metal mixer of 800-tons capacity under assembly.







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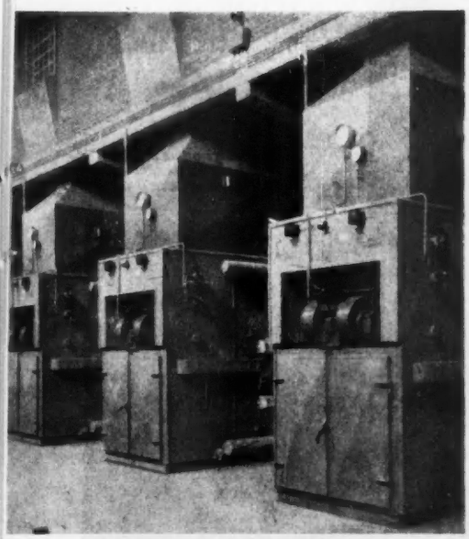

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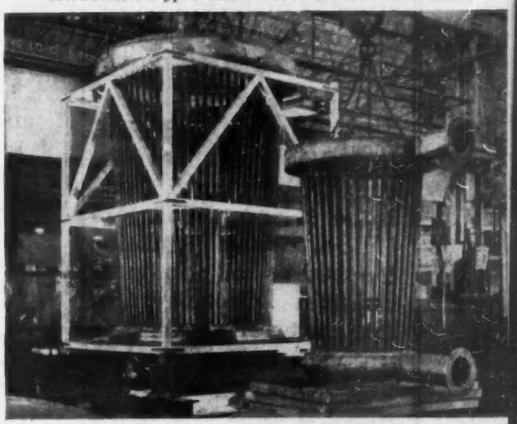
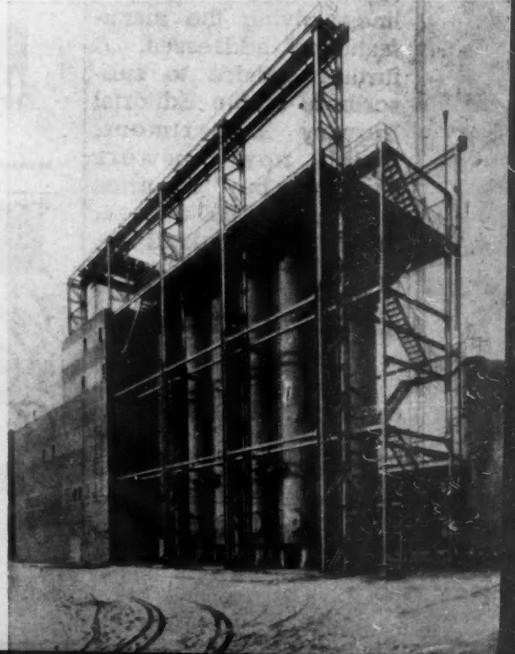
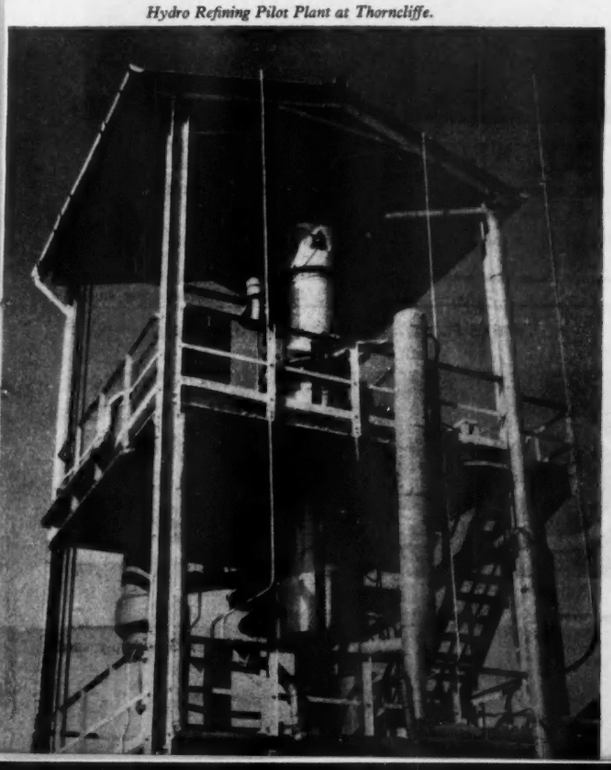
INKA Radiant type Preheater tube bundles under construction.



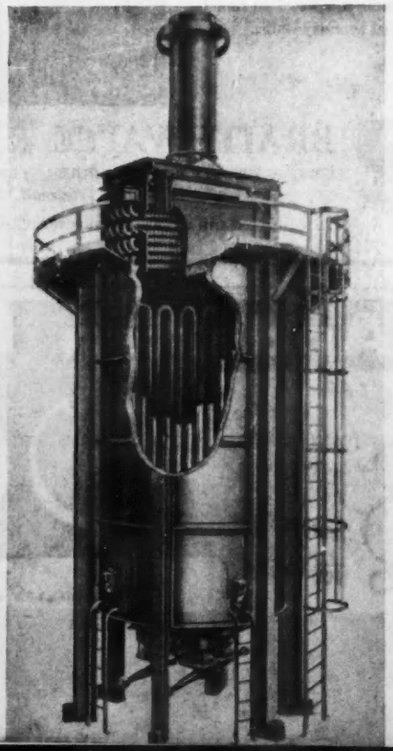
A typical Newton Chambers Bischoff high pressure purification plant.



Hydro Refining Pilot Plant at Thorncliffe.



Struthers Wells direct-fired heaters.



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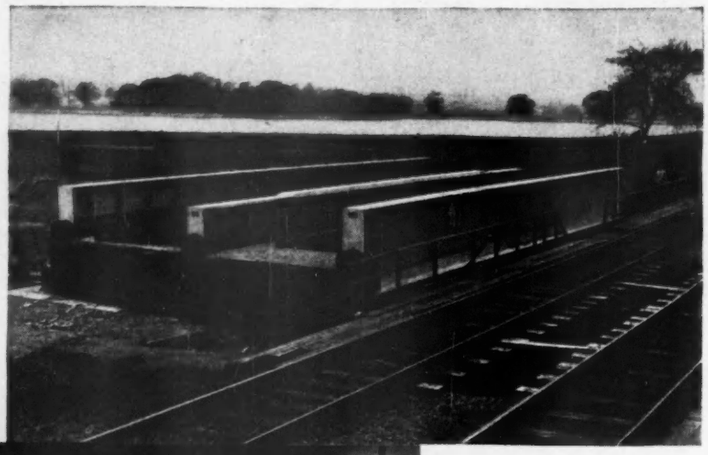

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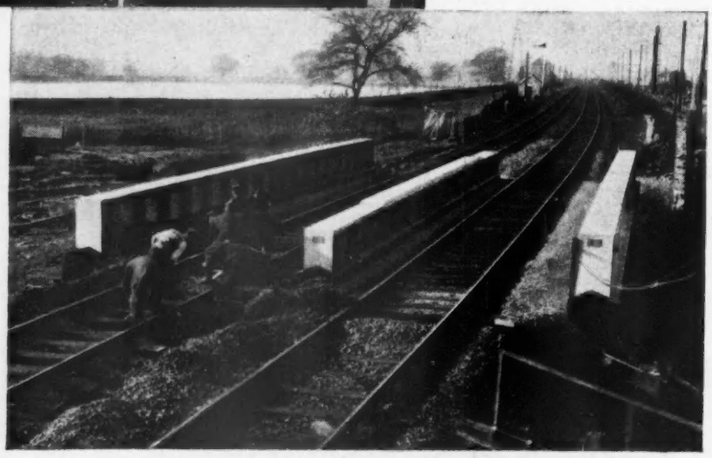

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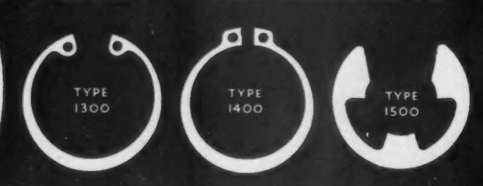

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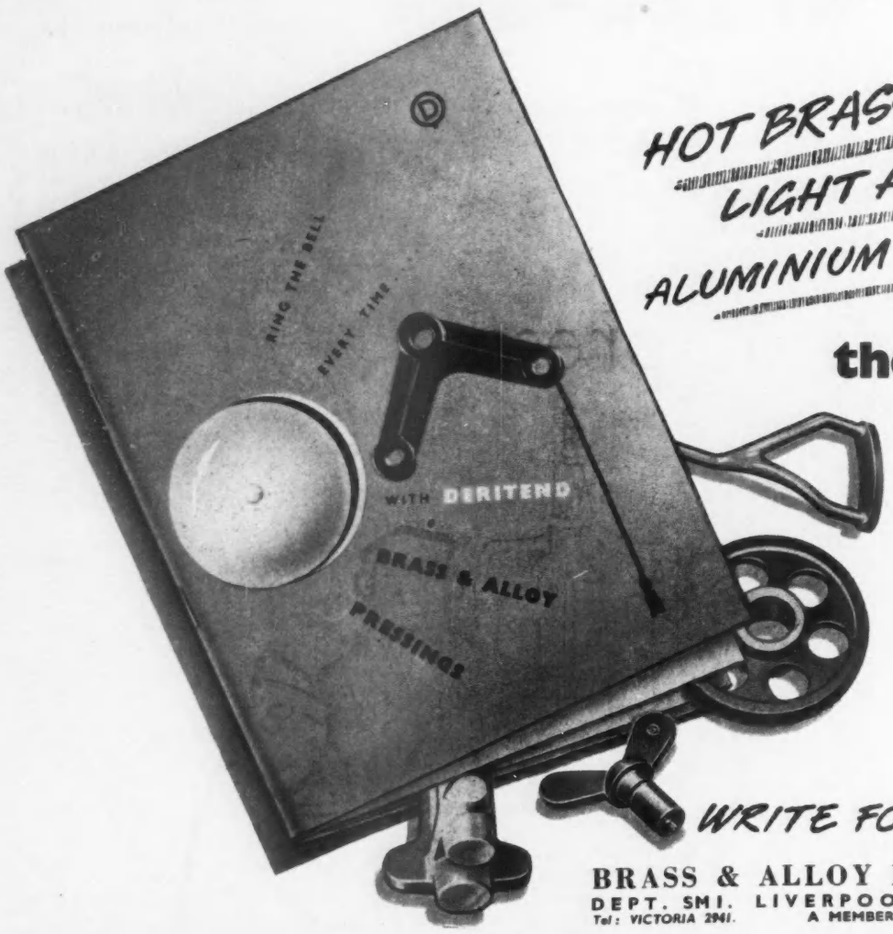

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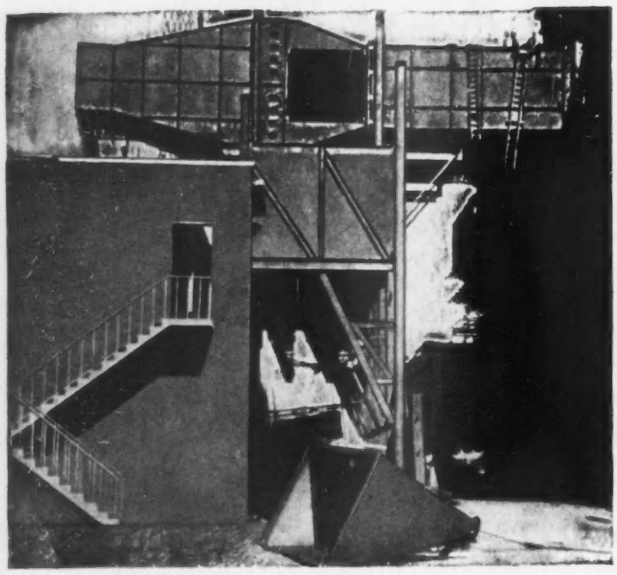

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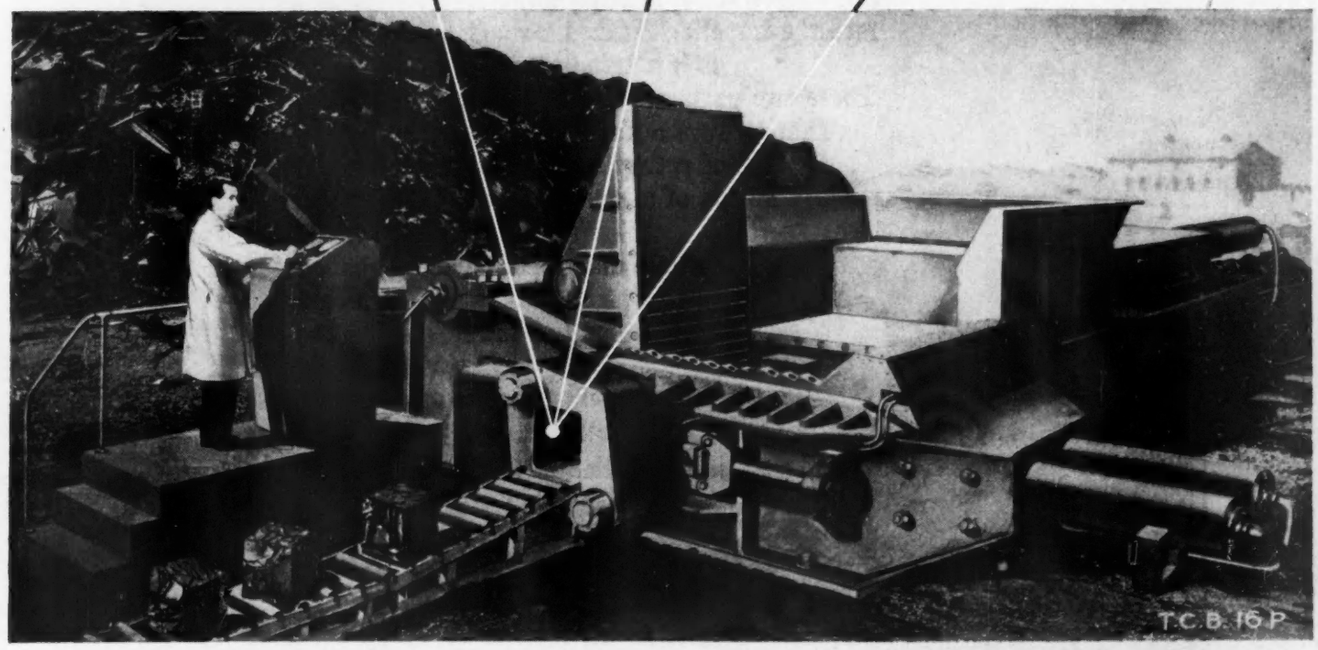

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To-day we have naming of parts,
To-morrow we may have fitting of parts,
F'rinstance, pump parts or parts of pumps,
No matter—pump parts must be named,
Take the impeller, sometimes known as the fan or rotor,
But to-day it's the impeller—Don't ask why
Then we have on the impeller inlet or eye
A bearing ring, oftimes called a wearing ring even clearance ring,
But to-day it's a bearing ring.
Into the impeller is fitted a shaft, or is it a spindle? never rod.
These two parts are held from turning.
That is from a kind of differential rate of rotary motion (which is not good)
By means of a key which we are calling a feather,
The whole diabolical device is placed in a casing
Which has two branches—one the inlet t'other the delivery,
But to-day, for the sake of clarity we will call them suction and discharge.
And you, in the back seat! What's the best name for the complete ensemble?

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(which is very good)

Drysdale have been making pumps since you looked like this—
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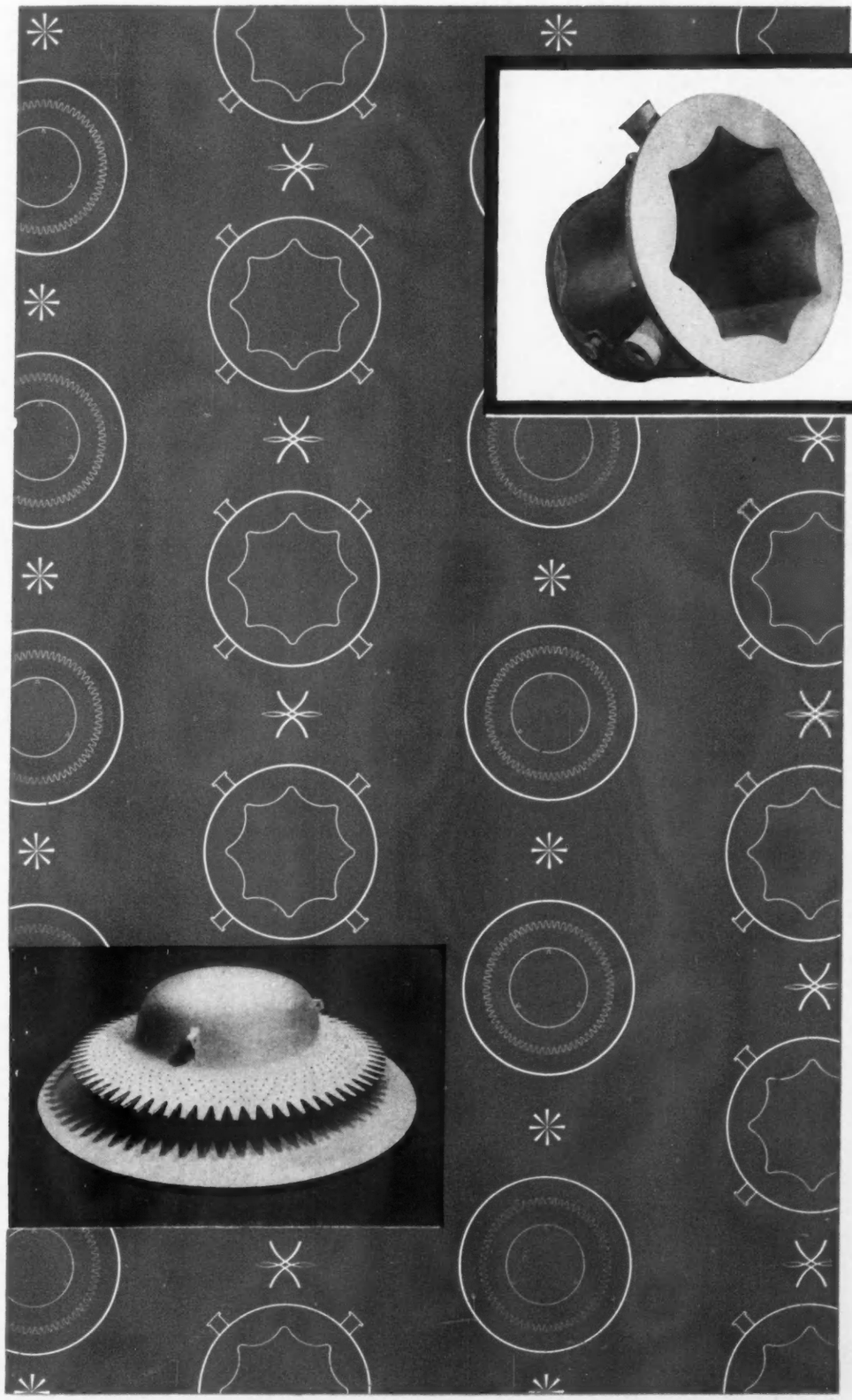

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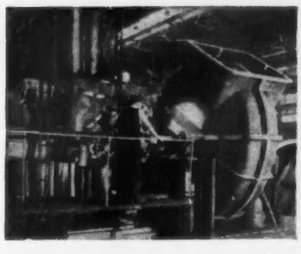

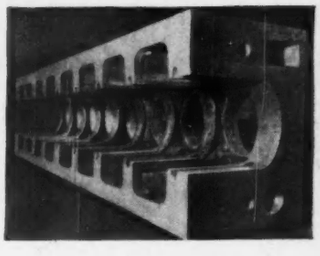

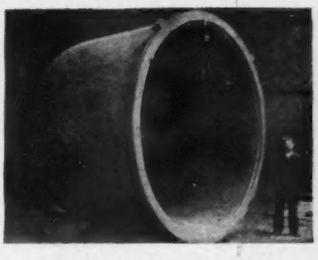

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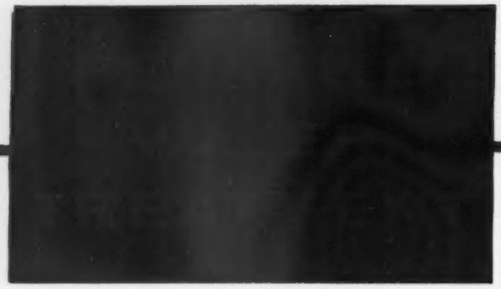

THE CONTROL PANEL shown on the opposite page will do an important job at the Carrington Works of the Shell Chemical Company Limited: it will control the fully automatic PERMUTIT plant producing nearly a million gallons daily of very pure water for boiler feed. This plant is typical of many recently designed and manufactured by Permutit for new industrial projects.

In every manufacturing process, water is an essential basic material. Steel, oil, chemicals, textiles: all rely on large quantities of water that must be purified to exacting standards. For some purposes, clean and sparkling filtered water meets the need, and for others, scale-forming salts must be eliminated. More critical applications call for water completely free from all dissolved solids: water of this high purity is produced cheaply in any quantity by Permutit plant.

In Electronics, very pure water is essential in many production processes—particularly in the manufacture of cathode ray tubes, and in the preparation of germanium wafers for transistors. This water is produced by Permutit "Deminrolit" plant—it is so pure that care must be taken to avoid its contamination by atmospheric impurities.

In Aviation, the galleys on Comets are equipped with Permutit drinking water filters, and Permutit De-Salting Kits are provided in emergency survival dinghies. On the Boeing 707, hundreds of gallons of pure water—by Permutit—are injected into the turbo-jets to give increased thrust for take-off.

In Ford's new Paint, Trim and Assembly Works, body shells are repeatedly rinsed with water during the stages of spraying and rubbing down. To ensure perfect finish, very pure water is needed: a Permutit plant supplies treated make-up, and also purifies dirty water for re-use.

In Britain's Nuclear and Fossil Fuel Stations, the make-up for the boilers is treated by Permutit "Deminrolit" plant that provides water free from silica and dissolved solids, with an electrical conductivity of less than 0.5 micromhos per cm^3.

You use water in your industry, but is its quality good enough for today's needs or tomorrow's planning? Bad water can ruin expensive plant and make process costs uneconomic: good water by Permutit saves money and often opens the way to better manufacturing methods.

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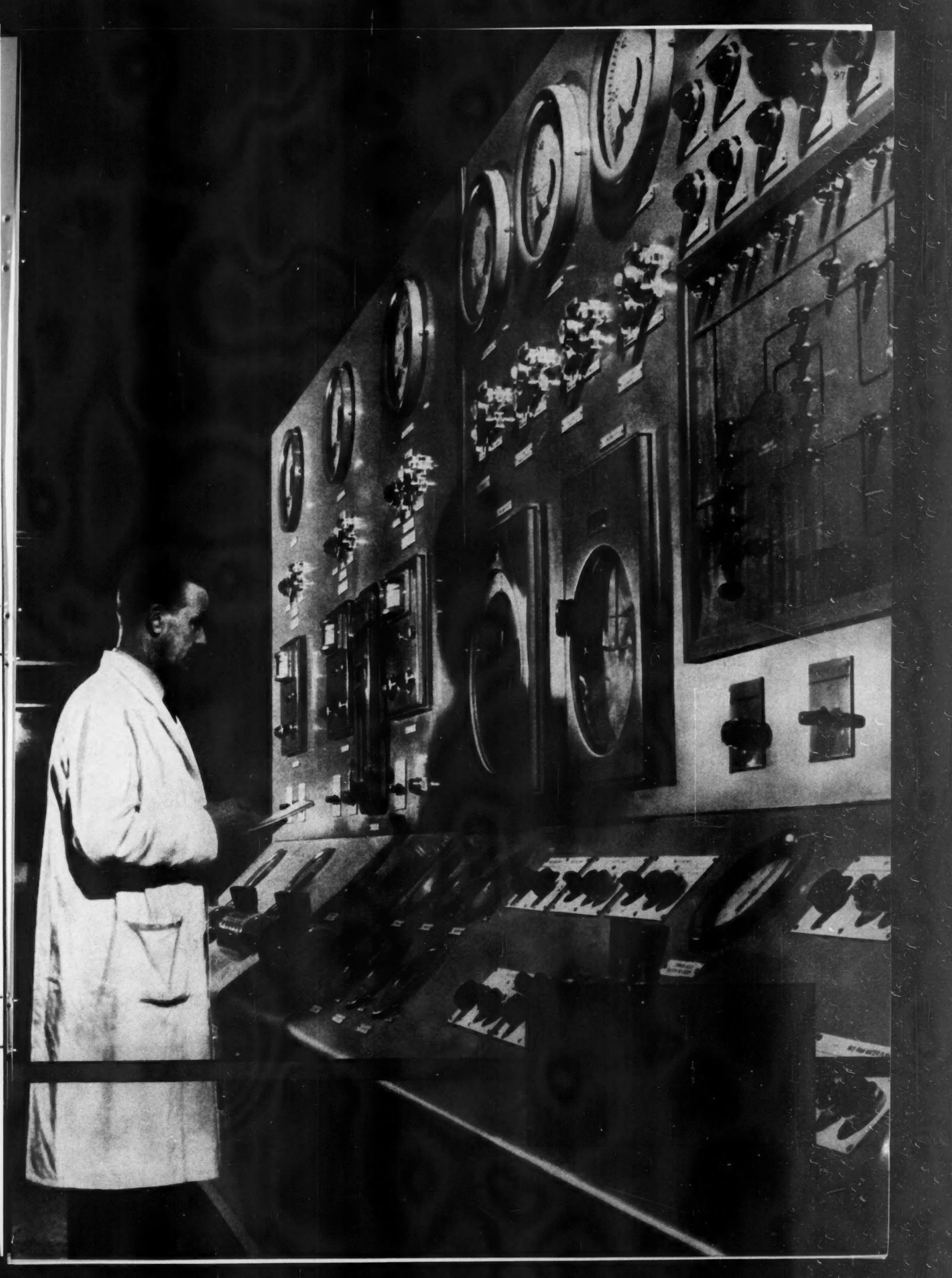

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BIG SHOCK FOR BRITISH INDUSTRY

But ANDRE RUBBER limits the repercussions

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A 557-TON MASS of machinery and pre-stressed concrete forms part of a power hammer used by the Armament Research and Development Establishment to simulate the shock produced by the discharge of the very biggest guns.

Normally in the development of heavy artillery, proof testing is carried out on a remote range, and to have set up this very heavy plant at all in a congested area is a fact of outstanding importance to industry.

Two-Mile Radius

Using an industrial hammer of equivalent power on a conventional foundation—remembering that the 450 tons of the concrete base alone is subjected to a "kick" acceleration of 15g—the ground vibration would not only have seriously interfered with work in the test house itself and disturbed delicate instruments in nearby laboratories and workshops, but have been great enough to amount to a "nuisance" according to Acts of Parliament, at distances up to two miles from the centre of the disturbance, varying with the nature and density of the ground.

Detailed study by the Consulting Engineer, Mr. J. H. A. Crockett, B.Sc.(Eng.), A.M.I.C.E., revealed the precise nature of the shock waves, internal flexural behaviour oscillations and resultant fatigues likely to be produced by the very high local accelerations involved.

Dramatic Improvement

This led to the design and construction of a special shock-controlled foundation incorporating six special Andre Rubber Sandwich Springs, which are believed to be the largest ever used for a machine. They were developed after close co-operation between the Consulting Engineer and technicians of the Andre Rubber Company.

The degree of vibration insulation achieved (99%) is phenomenal, ground vibration becoming imperceptible at a distance of only 120 feet. This may well be without equal for such heavy plant anywhere in the industrial world.

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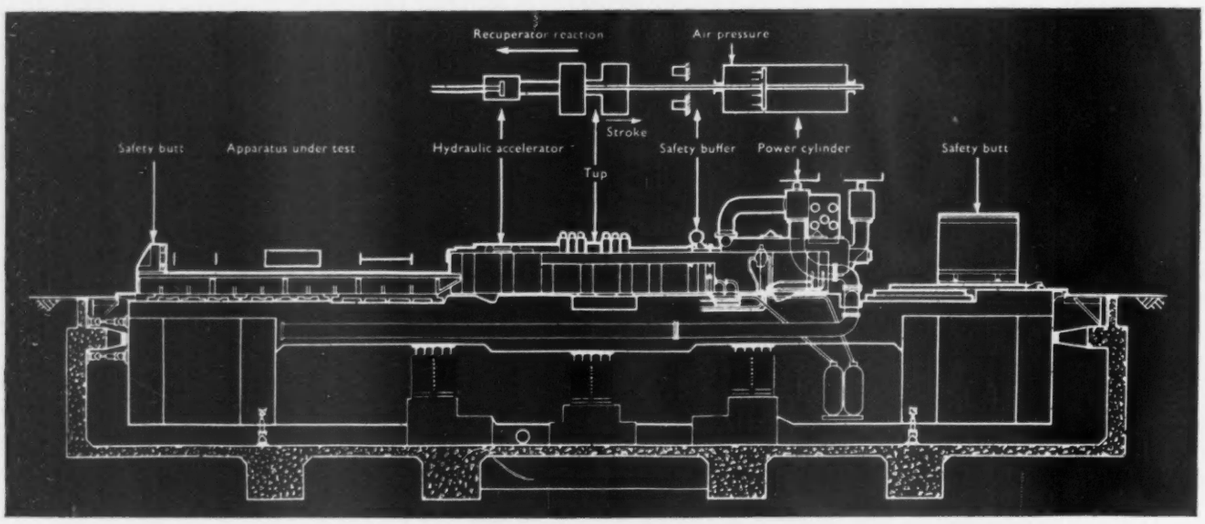
Main Rubber Spring, compressed

"Know-How"

The Fort Halstead test-hammer installations (for which some very large safety buffers were also designed) provides a typical demonstration of Andre Rubber's unrivalled experience and "know-how" in every aspect of engineering in natural and synthetic rubbers.

Many techniques that are now commonplace were pioneered and developed by the Andre Rubber Company.

Among the many heavier applications in which Andre Rubber's experience is unequalled are: railway suspension systems, harbour resilient fender systems and steel-reinforced rubber bearings for rail and road bridges.



GENERAL ARRANGEMENT OF TESTING MACHINE AND SPRING SHOCK-PROOF FOUNDATION

In this simplified drawing, the Andre Rubber Springs are shown in black

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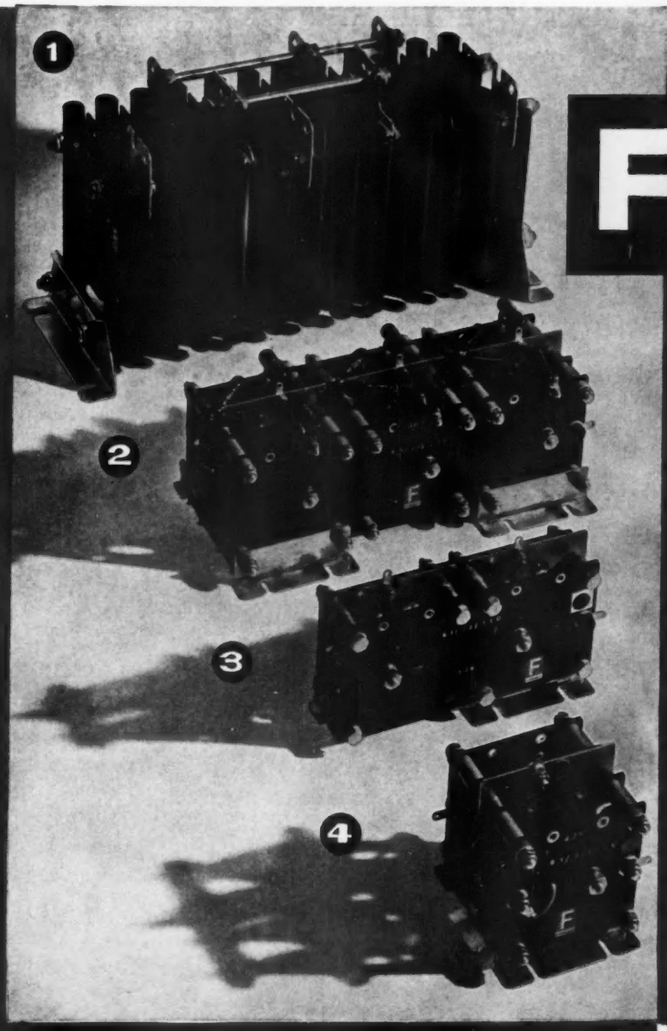

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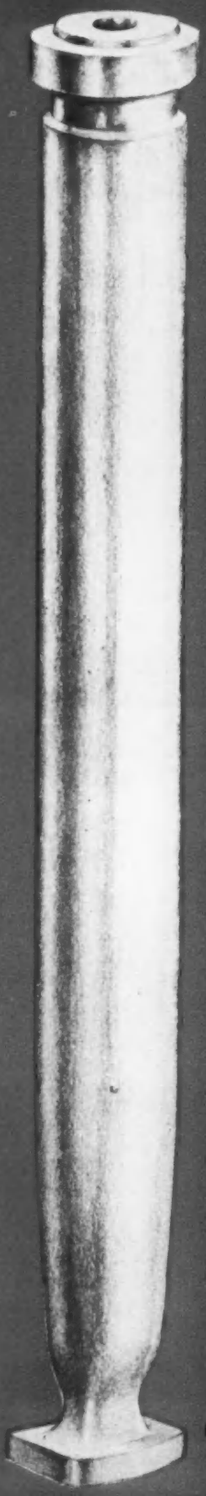
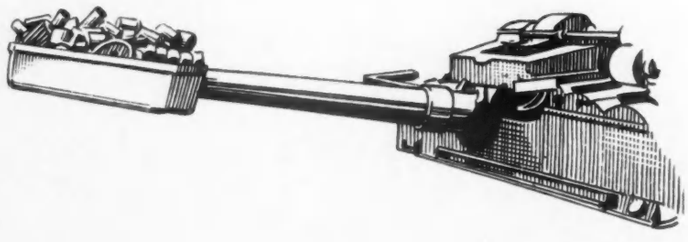


This Furnace Charging Arm used less material and reduced machining time drastically when made as a one-piece casting in a modern steel foundry. Compared with earlier production methods, a steel casting gave increased resistance to thermal and mechanical shock loading, thus lengthening life expectation, and showed a direct cost saving of 15% on each Arm.

You can take advantage of steel foundry know-how and ensure that your steel components are produced economically by calling in a steel foundry engineer at the design stage.

with reduced machining and longer life



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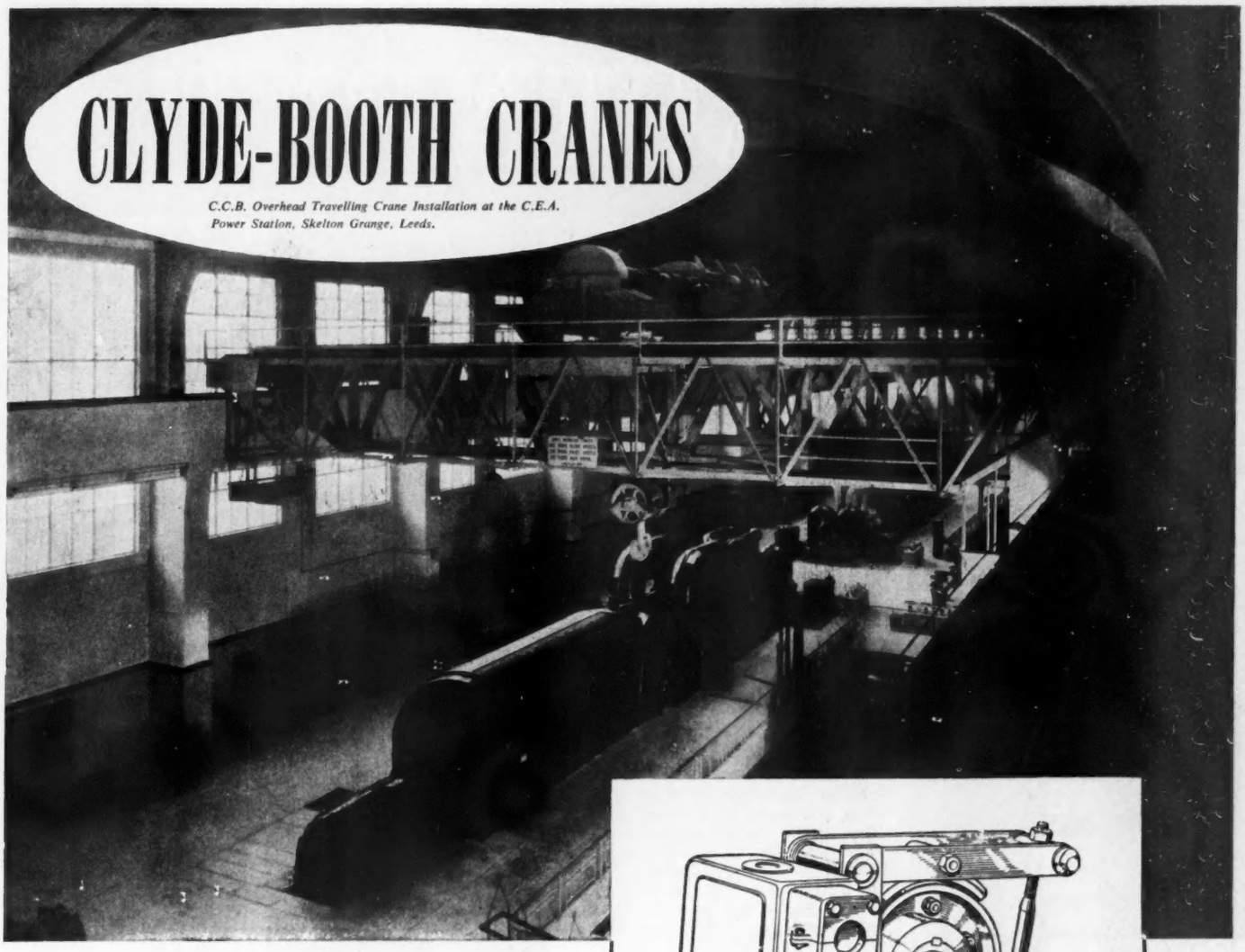

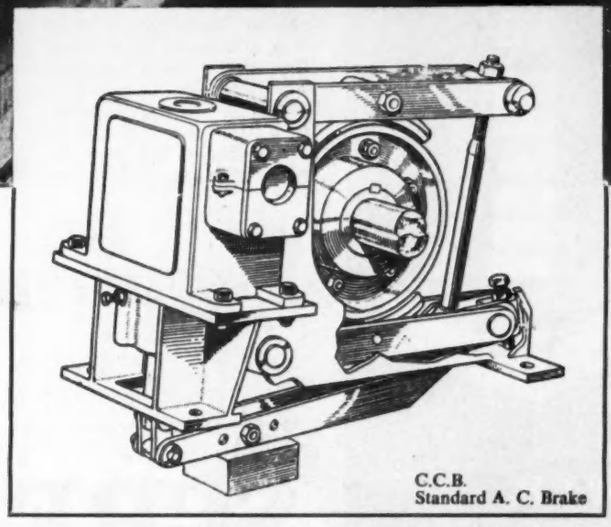

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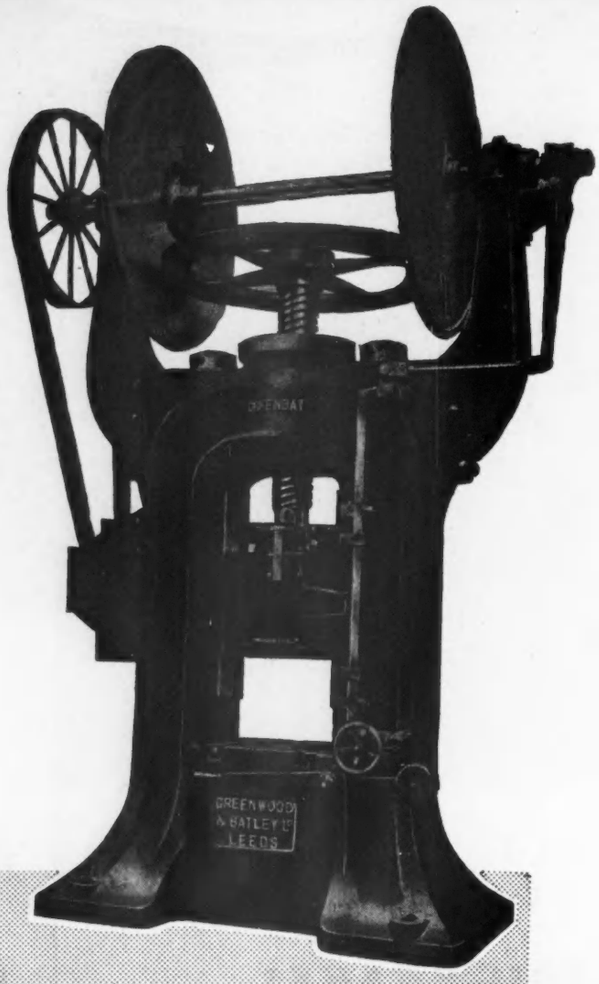

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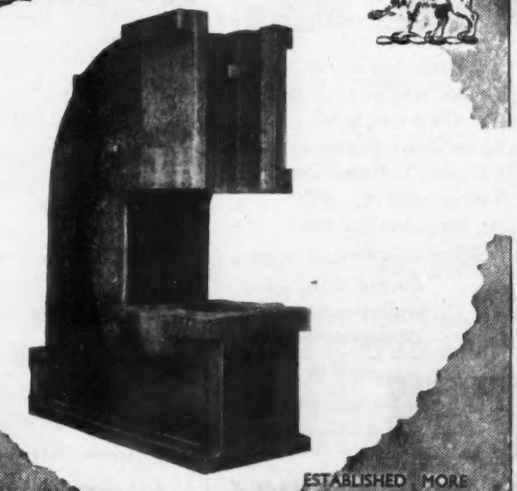

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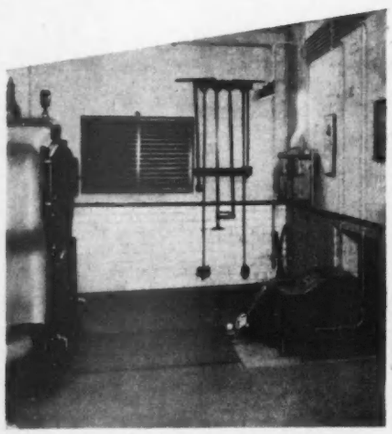

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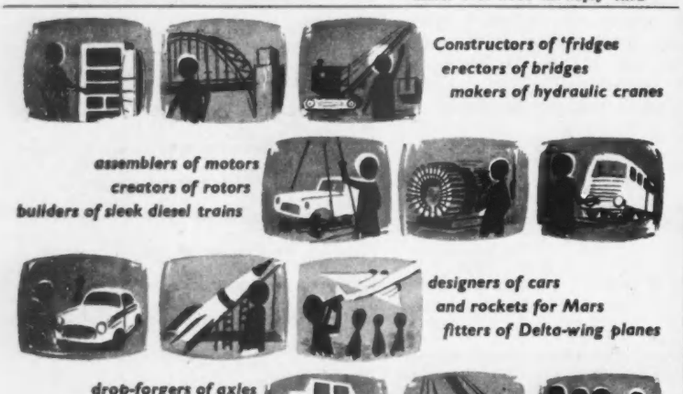

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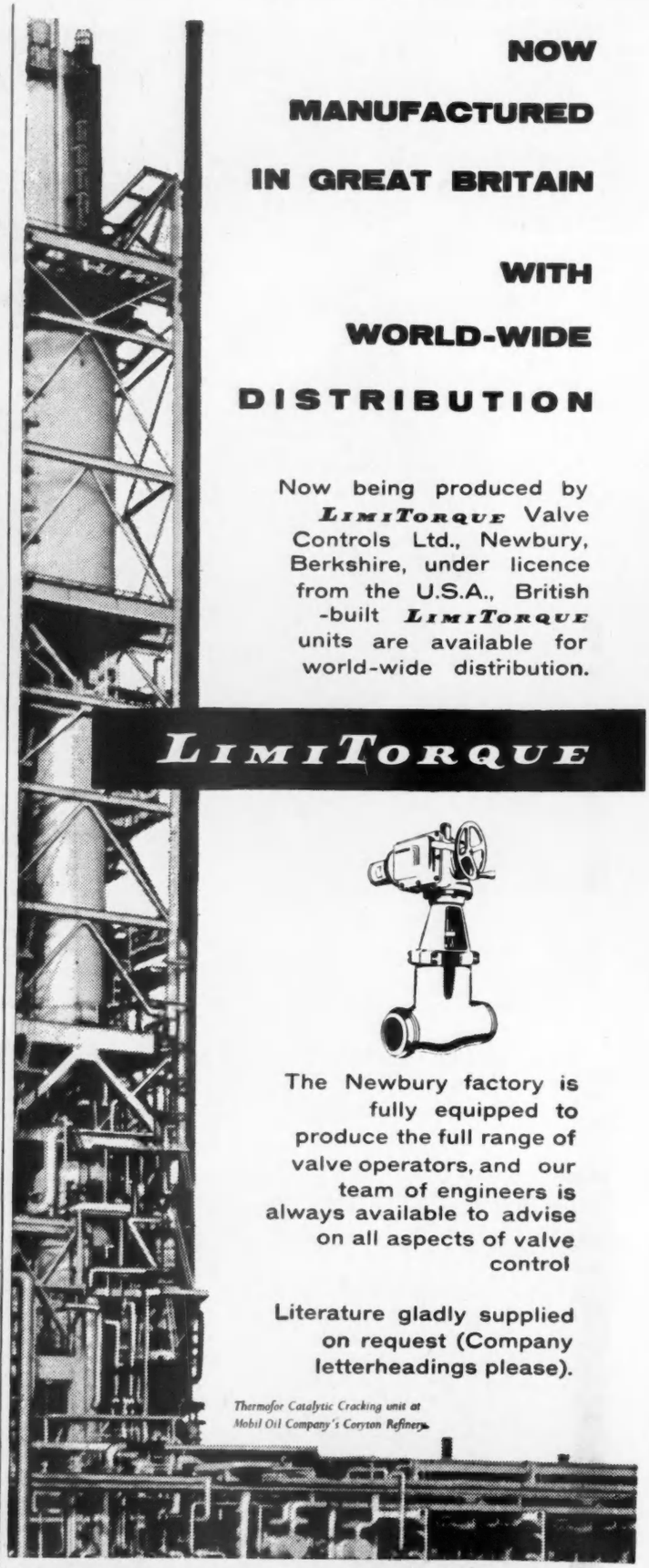

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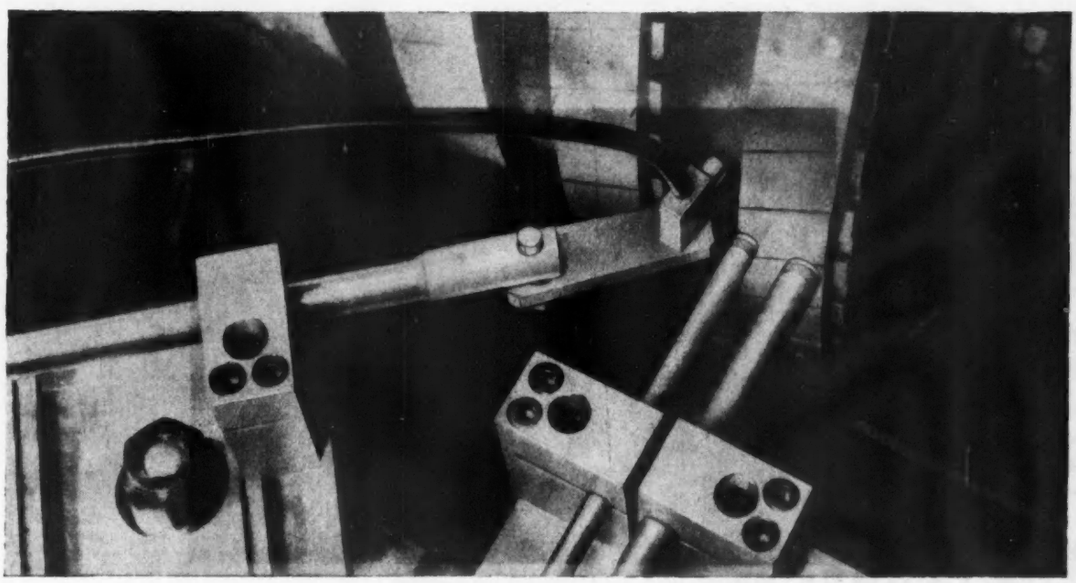

Three measuring probes in position before the turbine was set in motion

The following is drawn from a report by Bristol Siddeley Engines Ltd., on the use of WAYNE KERR Electronic Measuring Instruments:

"Development work in the field of gas turbine engineering frequently involves measurement of the degree of distortion occurring in compressor and turbine rotor assemblies at high rotational speeds. The observations required may be the straightforward diametral growth of simple discs or more complicated axial deflections caused by system asymmetry.

"Measurements of this type must be performed using a non-contacting device, the accuracy of which is unaffected by the peripheral speed of the specimen. Although optical devices have been employed, the capacitance probe system illustrated has proved to be the best solution to the problem from the points of view both of the accuracy of measurement and the range of observations which can be attempted.

"Photograph No. 1 (reproduction above) shows a typical rig assembly in which the specimen is an axial compressor rotor. For rig purposes the blades have been replaced by dummy blade weights of equivalent mass to the true blading, and the periphery has been ground to provide a cylindrical reference surface. The two guard ring probes in use on the dummy blades at the left end of the compressor rotor are used to indicate the elastic radial dilation and the degree of tilt occurring at this point.

"The remaining probe, which is fitted with a swivel head, is sensitive to displacements in the axial direction and is measuring the axial movement at the side of the dummy blade weights."

The report then gives details of the equipment's performance, quoting a discrimination better than 0.0002″ at 0.080″. It goes on:

"The general accuracy of measurement of the bare equipment is considerably better than ±1%, but the overall accuracy under rig conditions is influenced by other factors, such as rotor movement in the bearings, and general mechanical and thermal distortion of the rig and probe supports as a whole. It is estimated that in favourable circumstances measurement accuracies are of the order of ±2%."

Such precision under dynamic conditions cannot be attained by other methods. This means that Wayne Kerr electronic measuring techniques and equipment offer unique advantages when vibration, dilation and axial movement are to be gauged in the manufacture, testing or operation of large engines, electric motors, hydro-electric turbines, generators and a host of industrial processes where extreme accuracy is essential.

Furthermore, as the equipment includes output facilities for recording or warning devices, it can be used to give direct performance recordings and also to operate alarm or safety devices when any predetermined condition is reached.

All Wayne Kerr measuring instruments have simple direct reading facilities and can be operated with complete efficiency by personnel having no special knowledge of electronic theory.

Distance Meter DM100 · Vibration Meter B731A · Electronic Micrometer B721

Electronic Distance Measuring Instruments, for every application

WAYNE KERR

FOR FULL DETAILS, WRITE NOW FOR LEAFLETS

THE WAYNE KERR LABORATORIES LIMITED
Sales and Services 44 Coombe Rd., New Malden, Surrey *Telephone:* MALden 2202

WK9

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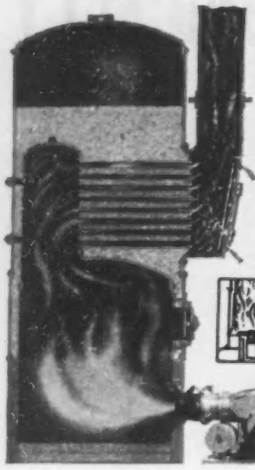

Coal — Coke — Wood or Oil-fired!

The COLTMAN 'ECONOMIC' Boiler construction allows for speedy adaptation. Possessing greater heating surface than most boilers, Thermal efficiency is increased. Oil-burning units can be fitted for land and marine purposes.

The 'ECONOMIC' has many important and outstanding features including — Quick Steaming Capacity. No Brickwork Setting. Economy of Floor Space. Accessibility giving Ease of Maintenance.

With Automatic Stoker or Burner fully complies with the Clean Air Act.

(Feature Illustration.) With 'NU-WAY' Fully Automatic Oil Burner.

(Inset.) With Ashwell & Nesbic Automatic Coal Stoker.

WALTER W. COLTMAN & CO. (BOILERS) LTD.

CENTRAL BOILER WORKS : LOUGHBOROUGH

Tel: Loughborough 2351 *Grams: Boilers, Loughborough*

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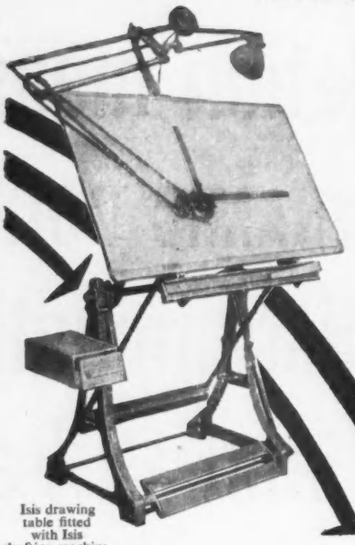

Isis drawing table fitted with Isis drafting machine

ISIS

DRAFTING MACHINES AND DRAWING TABLES

ISIS Drafting Machines are now fitted with improved Protractor heads, the special features are fully explained in our ISIS catalogue, which will be gladly sent on request. The ISIS Drawing Tables are in complete balance at any height or inclination of the board.

Isis studio drafting machine on Isis tubular stand. This is a light-weight precision machine for smaller sized boards up to 42"x 29".

Isis drawing table fitted with parallel motion straight edge.

J.W.SMITH (COV. NTRY) LTD

DRAWING OFFICE SUPPLIES AND EQUIPMENT

36 & 41 QUEENS ROAD, COVENTRY

RIEFLER

We are distributors of Drawing Instruments of quality

ARISTO

slide rules of precision

Grams : 'ISIS' Coventry. Tel : Cov. 62058-9.

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ARTUS

PRECISION PLASTIC SHIMS

From ·0005" up to ·040"

"THE COLOUR TELLS THE THICKNESS"

There is an "ARTUS" grade for most Chemical and Thermal Conditions

EASY TO IDENTIFY - EASY TO USE

Write for Samples and Literature or Mail Blueprint for Quotation.

AUTO AERO LTD.

44 PACKINGTON ROAD LONDON W.3 *Telephone ACORN 0544*

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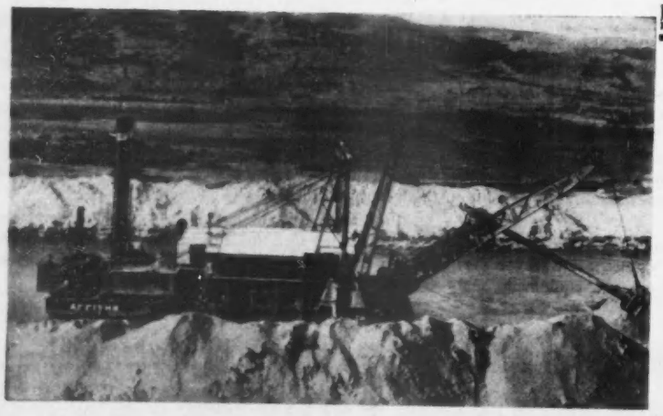


6-yard oil-fired Steam Dipper Dredger, built for the Greek Government. Output 255 cubic yards of cobbles and boulders per hour dumped to a radius of 90 feet and a clear height of 30 feet.

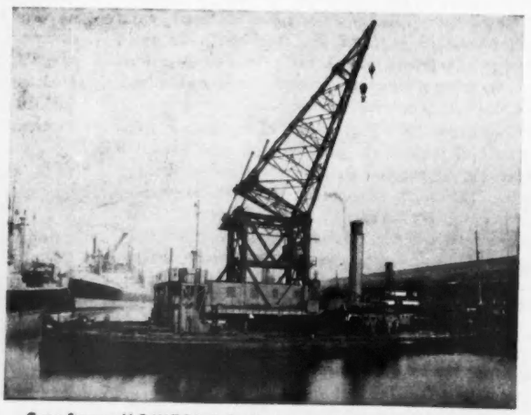
DREDGING PLANT

to the Largest Dimensions and Capabilities.

PATENT CUTTER HOPPER DREDGERS, PATENT DIPPER DREDGERS, BUCKET DREDGERS, GOLD & TIN RECOVERY DREDGERS, FLOATING CRANES

Hopper Barges
Screw Steamers,
Side and Stern Paddle Wheel Steamers, Tugs, etc.

New Buckets, Links, Pins, Gearing etc., supplied for existing Dredgers



Crane Steamer M.O.W.T.8 built for Ministry of War Transport. Dimensions: 173 feet by 57 feet by 12 feet 6 inches. Load : 60 tons at 80 feet radius.

FLEMING & FERGUSON LTD.

Phone : Paisley 4121. SHIPBUILDERS & ENGINEERS, PAISLEY, SCOTLAND. *Tel. Add.: "Phenix Paisley."*

London Office: 54-62 REGENT STREET, W.1. *Phone Regent 6247*

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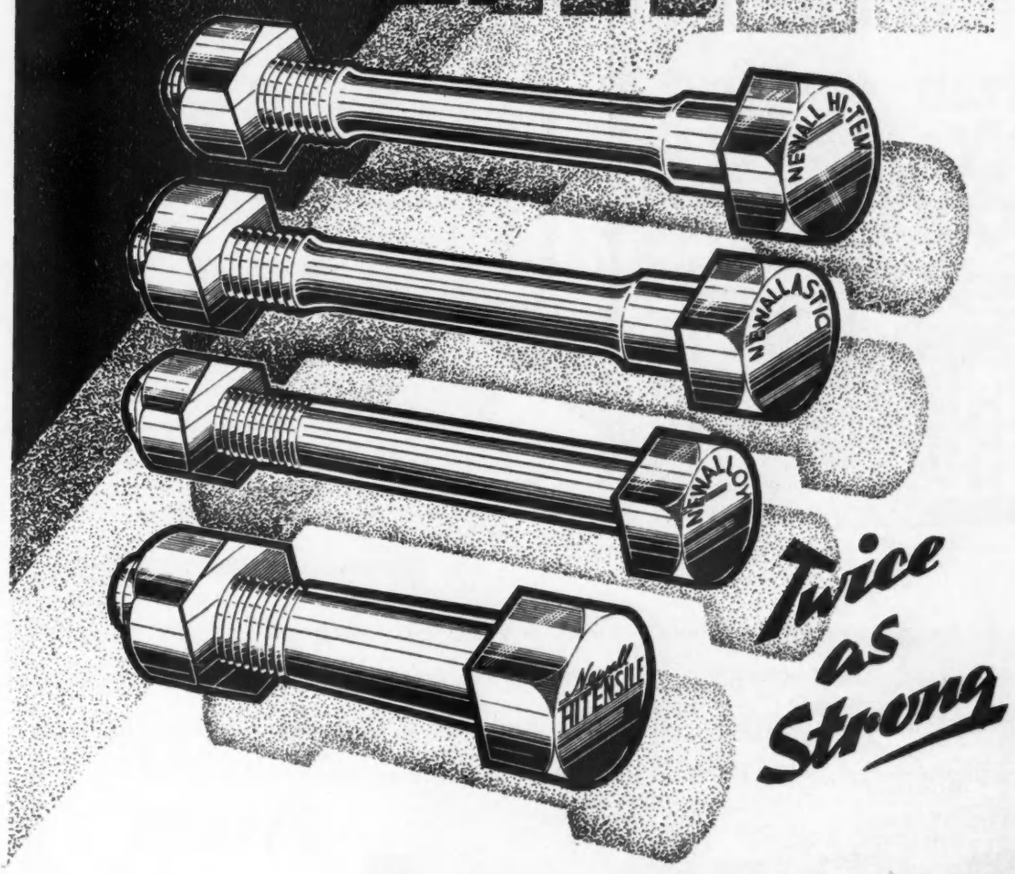
NEWALL



Twice as Strong

NEWALL BRANDED BOLTS

Newall Hitensile . . . Newalloy . . . Newallastic . . . Newall Hi-tem . . .

are recognised by engineers as having unique qualities. We shall be happy to supply any engineer designer who is interested with details of the various bolts and studs, which cover the full range of modern requirements.

A.P.Newall
AND COMPANY LIMITED
POSSILPARK · GLASGOW N.2.

ALSO AT LONDON AND BIRMINGHAM

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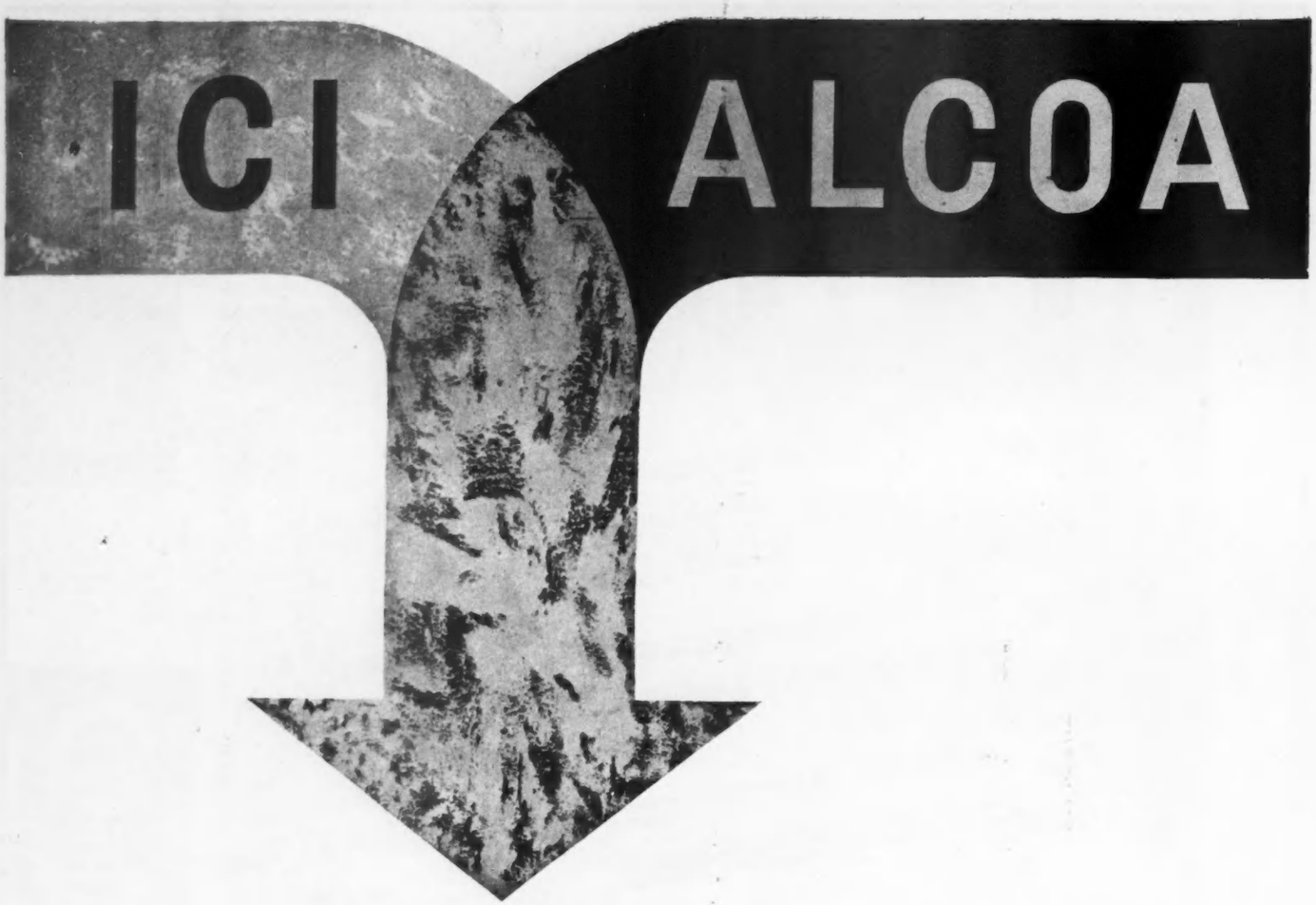

These names make aluminium news. Imperial Chemical Industries and Aluminum Company of America, household words on both sides of the Atlantic, combine to form a new name in aluminium—*IMPALCO.* Backed by ALCOA's unmatched experience in the specialised field of aluminium and by I.C.I.'s great resources and world-wide organisation, ***IMPALCO*** will provide a new major source of aluminium.

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for aluminium

Imperial Aluminium Company Limited · Birmingham

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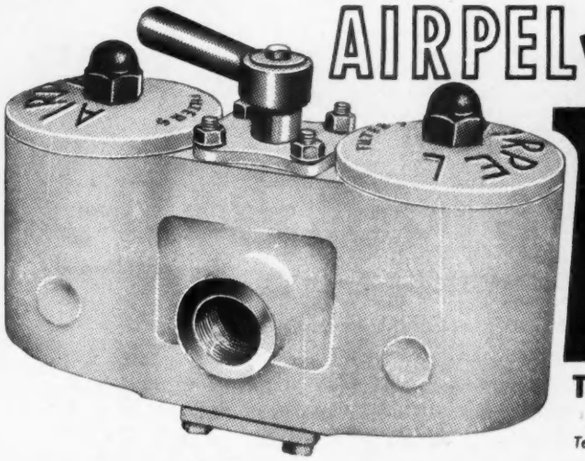

AIRPEL SINGLE & DUAL FILTERS FOR FINER FILTRATION OF ALL LIQUIDS

★ LARGE CAPACITIES ★ LOWEST PRESSURE DROP
★ DUAL TYPE GIVES UNINTERRUPTED FLOW ★ SINGLE NUT COVER FIXING
★ HIGHLY COMPETITIVE

IMMEDIATE EX-STOCK DELIVERIES FROM OUR 11 DEPOTS THROUGHOUT THE U.K. AND EIRE.

THE BRITISH STEAM SPECIALTIES LIMITED
Head Office: FLEET STREET · LEICESTER
Also at LONDON, LIVERPOOL, GLASGOW, BRISTOL, MANCHESTER, NEWCASTLE-ON-TYNE, BIRMINGHAM, BELFAST, DUBLIN, CARDIFF.
Telephone: LEICESTER 20885 (6 lines) Telegrams: "BOSS" LEICESTER
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CASTINGS

HIGH QUALITY ENGINEERING & MACHINE TOOL CASTINGS

HEAT & WEAR RESISTING UP TO 10 TONS also in SPHEROIDAL GRAPHITE IRON & STEEL

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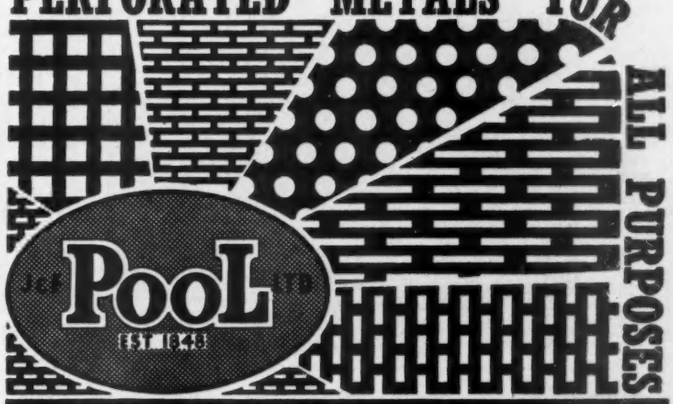
PERFORATED METALS FOR ALL PURPOSES



HAYLE, CORNWALL Tel. Hayle 3213
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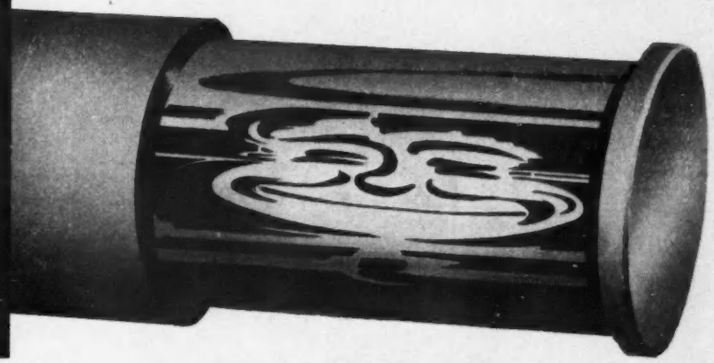
'ORKOT' POLISHES SHAFTS



—which increases both bearing and shaft life. But when you change to 'ORKOT' you ALSO get :

* a hard wearing modern bearing material,
* an unusually low coefficient of friction,
* reduced power losses on bearings,
* maximum flexibility with lubricants,
* resistance to most chemicals,
* freedom from corrosion,
* reduced maintenance costs.

You should know more about 'ORKOT'

UCC CHEMICALS FROM COAL

* Orkot BUSHES

Write to:

UNITED COKE & CHEMICALS COMPANY LIMITED
(SALES DEPARTMENT 47) P.O. BOX 136, HANDSWORTH, SHEFFIELD, 13.
Telephone: WOODHOUSE (SHEFFIELD) 3211 Telegrams: UNICHEM, SHEFFIELD
08.2
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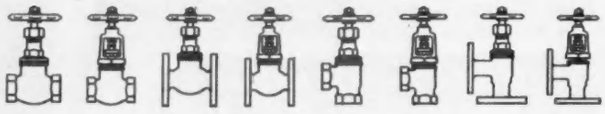
Dependable
Dual-Purpose Bronze Valves

Hopkinsons' "S.T.S." bronze valves, with their mitre-faced valve heads and seats are suitable for use as either isolating or regulating valves. Note how the tapering metal-to-metal joint between body and seat helps to ensure complete fluid-tightness. This range of small valves, in fact, is acknowledged by users to be exceptional for maintaining tightness over very long periods of service, so simply are they designed and so sturdily made.

Available in sizes ¼ in. to 3 in. bore with screwed connections, and ½ in. to 3 in. bore with flanged connections.

HOPKINSONS LIMITED • HUDDERSFIELD
LONDON OFFICE: 34 NORFOLK STREET · STRAND · W.C.2



HV126

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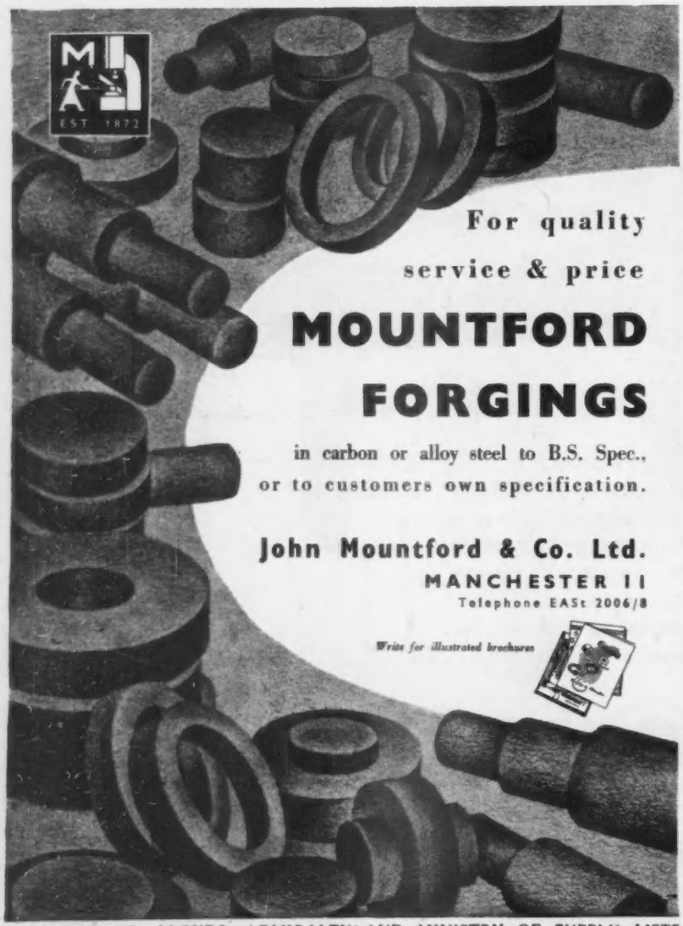

INCLUDED ON LLOYDS, ADMIRALTY AND MINISTRY OF SUPPLY LISTS
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PRIME ★ ★ PLATE

SPECIAL OFFER

IN SIZES OF
3′ x 1′ Minimum up to
8′ x 22″
in the following thicknesses

3/16″	1/4″	5/16″	3/8″
7/16″	1/2″	9/16″	5/8″

Excellent for small profile work

★

LET US QUOTE YOU FOR THESE PLATES— SHEARED, PROFILED OR FORMED TO YOUR OWN REQUIREMENTS

★

A. KING & SONS
NORWICH
Telephone: NORWICH 28541 (5 lines)
Telegrams: METALLURGY-TELEX 1277

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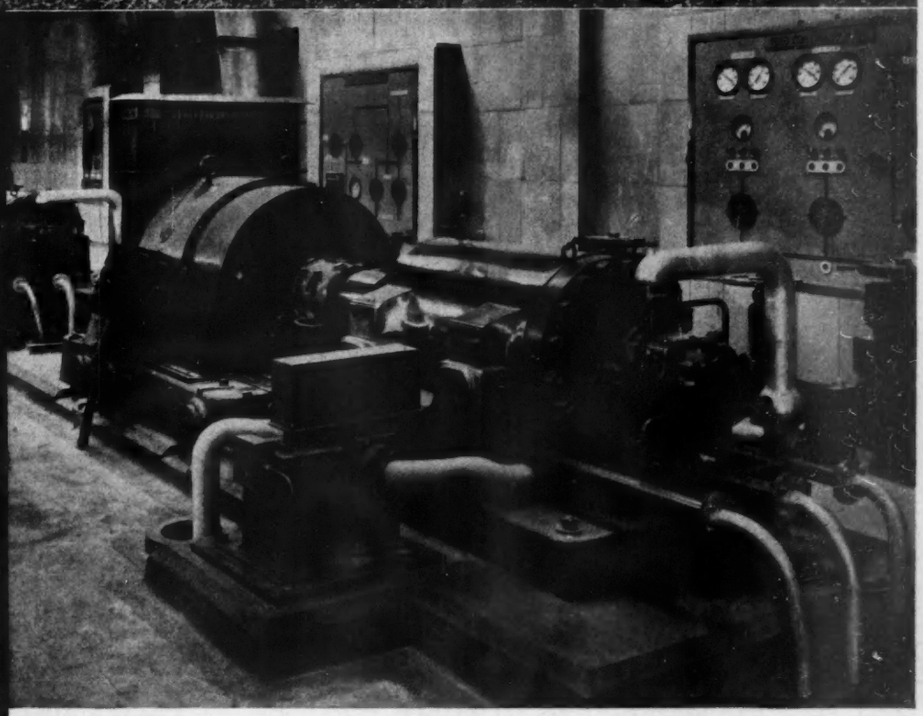
SULZER



1 Pump capable of delivering 1,065 gallons per minute against a head of 2,940 feet with water at a temperature of 220° F. Driven by a 1,400 BHP motor.

2 Pumps each capable of delivering 917 gallons per minute against a head of 2,940 feet with water at a temperature of 220° F. Driven by 1,200 BHP motors.

Installed in Brighton Power Station for the Central Electricity Generating Board South Eastern Division

Telephone: MUSeum 7890

SULZER BROS. (LONDON) LTD.

Incorporating Hathorn Davey & Co. Ltd.

31, Bedford Square, London, W.C.1.

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GOLDEN JUBILEE

On their Fiftieth Anniversary

Acheson Colloids Limited

send greetings to users of

Acheson Dispersions

everywhere

ACHESON COLLOIDS LIMITED

PRINCE ROCK · PLYMOUTH · DEVON

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CLASSIFIED ADVERTISEMENTS

PUBLIC APPOINTMENTS · SITUATIONS VACANT · TENDERS · EDUCATIONAL · BUSINESSES and PREMISES · BUSINESS OPPORTUNITIES PATENTS · MISCELLANEOUS · AGENCIES · DIRECTORS · PARTNERSHIPS

Lineage Rate. 4/6 per line of approximately 6 words. **Minimum** 18/–. **Inch Rate.** 54/– per single column inch and pro rata. 12 lines to 1 inch.

There are reduced rates (i.e., not on a pro rata basis) for advertisements of ¼-page (12 column inches) and upwards, e.g., ¼-page £29 10s. ½-page £54. Full page £100.

FOR SALE · MACHINERY, etc., WANTED · AUCTION SALES · SITUATIONS WANTED · SUB-CONTRACTING · DESIGN SERVICES · FOR HIRE

Lineage Rate. 4/– per line of approximately 6 words. **Minimum** 16/–. **Inch Rate.** 48/– per single column inch and pro rata. 12 lines to 1 inch.

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Run-On and Semi-Displayed Styles. Both these styles are available for single column width advertisements of any depth up to 12 inches.

Displayed and Illustrated Styles. The minimum size for a Displayed advertisement is 3 inches single column, for an Illustrated advertisement it is a ¼-page (12 column inches). Thereafter the sizes for both progress in steps 3 inches deep across 1, 2, 3 or 4 columns.

Use of Box Number. 2/– which includes forwarding of replies.

Copy Dates. Tuesday for publication on Friday of the same week. If proofs are wanted, copy is required on Thursday for publication on Friday of the following week.

Advertisements for publication should be addressed to :—**Classified Advertisement Dept., "THE ENGINEER," 28 Essex Street, Strand, London, W.C.2**

Urgent advertisements may be telephoned to CENtral 6565.

PUBLIC APPOINTMENTS

UNIVERSITY OF HONG KONG

LECTURESHIPS

Applications are invited for the following posts :

1. LECTURESHIP IN MECHANICAL ENGINEERING

Applicants should hold a Degree in Mechanical Engineering from a British University, or its equivalent, preferably with First or Second Class Honours, and must be Corporate Members of the Institution of Mechanical Engineers. Preference will be given to applicants who have experience of teaching at University level and/or of research work.

The successful applicant will be required to lecture in Machine Design and Production Engineering and may be required also to assist in other courses. He will be expected to engage in research. The successful applicant will be requested to commence duties in September, 1960.

2. LECTURESHIPS (2) IN ELECTRICAL ENGINEERING

Applicants should hold a Degree in Electrical Engineering from a British University, or its equivalent, preferably with First or Second Class Honours, and must be Corporate Members of the Institution of Electrical Engineers. Preference will be given to applicants who have experience of teaching at University level and/or of research work.

The successful applicants will be required to lecture in : (a) Electrical Machines and Electrical Measurements ; (b) Light Current Electrical Engineering and Applied Electronics ; they may also be required to assist in other courses. They will be expected to engage in research. Successful applicants will be requested to commence duties in September, 1960.

Annual salary (superannuable) is £1575 by £50 to £2175 for a man, or £1200 by £40 to £1680 for a woman. There is also an expatriation allowance of £225 a year if applicable. The equivalent of income tax in the Colony is comparatively low.

First-class sea passages are provided for expatriate staff and their families on first appointment and leaves. Accommodation at reasonable rental is provided for those receiving expatriation allowance.

Further particulars and information as to the method of application may be obtained from the Secretary, Association of Universities of the British Commonwealth, 36, Gordon Square, London, W.C.1.

Applications close, in Hong Kong and London, on 15th April, 1960. E9157

MIDDLESEX COUNTY COUNCIL
EDUCATION COMMITTEE

HENDON TECHNICAL COLLEGE, THE BURROUGHS, HENDON, N.W.4.

HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT

Applications are invited for the post of HEAD OF THE MECHANICAL ENGINEERING DEPARTMENT—Grade V.

The department provides a wide range of courses, including "Sandwich" courses at the Higher National Diploma level and has facilities for research.

Applicants for the post should have high academic qualifications. They should also have both industrial and teaching experience and they must be Corporate Members of the Institution of Mechanical Engineers.

Salary : £2100 by £50 to £2250.

London "Area" allowance is payable in addition.

Application forms and further detailed information may be obtained (s.a.e.) from the Chief Education Officer (F1), Middlesex County Council, 10, Great George Street, Westminster, London, S.W.1. Completed application forms should be returned by 25th March, 1960.

C. E. GURR, M.Sc., Ph.D.,
E9167 Secretary to the Education Committee.

ESSEX

THURROCK TECHNICAL COLLEGE

PRINCIPAL

Applications are invited for the post of PRINCIPAL of this COLLEGE from 1st September, 1960. Salary scale : £2000 by £50 to £2150.

The College buildings have been completed during the present session and the vacancy occurs on the retirement of the present Principal.

For further details and application form, send a stamped, addressed foolscap envelope to the Chief Education Officer, County Offices, Chelmsford. Closing date, 31st March, 1960. E9188

PUBLIC APPOINTMENTS

NATIONAL COLLEGE FOR HEATING, VENTILATING, REFRIGERATION AND FAN ENGINEERING

BOROUGH POLYTECHNIC, BOROUGH ROAD, LONDON, S.E.1

Director : JAMES E. GARSIDE, M.Sc.Tech., Ph.D., F.R.I.C., F.I.M., F.Inst.F.

Head of College : DAVID R. SCOTT, M.Sc., Ph.D., M.Inst.R., A.M.I.H.V.E., A.Inst.P., A.M.I.Min.E., A.M.E.M.E.

RESEARCH ASSISTANT

The Governors invite applications for the following appointment :

RESEARCH ASSISTANT.

Applicants should be University Graduates in Science or Engineering. Consideration will also be given to those expecting to graduate at the end of this present academic year. Applicants should have a knowledge of Automatic Controls and an interest in Process Control Engineering. Where a candidate's qualifications permit, the results of the research may be used for the purpose of gaining a higher degree. Publication is encouraged.

Salary : £600 p.a., and the post is superannuable after an initial period of one year.

Further particulars and Application Form, which should be returned as soon as possible, obtainable from the undersigned.

FREDK. J. PACKER,
E9166 Clerk to the Governing Body.

QUEEN MARY COLLEGE
(UNIVERSITY OF LONDON)

LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING

Applications are invited for the post of LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING. Applicants should have had at least two years of Civil Engineering practice. Experience in teaching and research will be an advantage. Tenable 1st October, 1960.

Salary scale : £900 by £50 to £1350 (efficiency bar) £1425 by £75 to £1650, plus London Allowance £60. F.S.S.U. participation and family allowance of £50 for each child.

Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, E.1, to be returned by March 22nd. E9158

UNIVERSITY OF LIVERPOOL

DEPARTMENT OF FLUID MECHANICS

LECTURER

Applications are invited for the post of LECTURER in the Department of Fluid Mechanics. The initial salary will be within the range £900–£1650 per annum, according to age, qualifications and experience. Candidates should have an Honours Degree, or its equivalent.

Applications, stating age, academic qualifications and experience, together with the names of three referees, quoting Ref. CV/E, should be received not later than 26th March, 1960, by the Registrar, from whom further particulars of the conditions of appointment may be obtained. E9135

QUEEN MARY COLLEGE
(UNIVERSITY OF LONDON)

LECTURER OR ASSISTANT LECTURER IN MECHANICAL ENGINEERING

Applications are invited for the post of LECTURER or ASSISTANT LECTURER IN MECHANICAL ENGINEERING.

Salary scales : Lecturer, £900 by £50 to £1350 (efficiency bar) : £1425 by £75 to £1650 ; Assistant Lecturer, £700 by £50 to £850, plus London Allowance of £60. F.S.S.U. participation and family allowance of £50 for each child. Initial salary according to qualifications and experience.

Application forms, obtainable from the Registrar, Queen Mary College, Mile End Road, E.1, to be returned by March 31st. E9139

PUBLIC APPOINTMENTS

NIGERIAN COLLEGE OF ARTS, SCIENCE AND TECHNOLOGY

SENIOR TECHNOLOGISTS OR TECHNOLOGISTS

Applications are invited for SENIOR TECHNOLOGISTS or TECHNOLOGISTS for the engineering laboratory and workshops for students preparing for University of London B.Sc. (Eng.) in Special Relationship.

Qualifications :

Electrical—H.N.C. desirable, and experience on maintenance and construction of electronic equipment and instrument maintenance.

Mechanical—H.N.C. or Final City and Guilds. Successful candidate required assist in teaching Engineering Drawing and Workshop Technology.

Contract Salary Scales : Technologist : £713–£1217 p.a. Senior Technologist : £1080–£1374 p.a., both plus inducement addition of £180–£300 p.a. for overseas appointees and gratuity at £25 or £37 10s. for each completed 3 months' residential service. Entry point according to qualifications and experience. Salaries quoted include an interim addition to basic salary recently approved pending salary revision.

Partly furnished houses at one-twelfth basic salary rental. Tours 15-18 months. Children's U.K. maintenance grant up to £150 p.a. and passages assistance.

Applications (8 copies), giving age, qualifications, experience and names of 3 referees, should be sent to the Council for Overseas Colleges, 12, Lincoln's Inn Fields, London, W.C.2, by 5th April, 1960. E9171

LONDON COUNTY COUNCIL

WESTMINSTER TECHNICAL COLLEGE, VINCENT SQUARE, S.W.1.

ASSISTANT, GRADE "B"

ASSISTANT, GRADE "B" required as soon as possible for H.N.C. Civil Engineering course ; graduate in Engineering or with equivalent professional qualifications and with industrial experience. Previous teaching experience an advantage.

Salary : £700 by £27 10s. to £1150 plus London allowance £38 or £51. Additions for qualifications and training. Increments within scale for experience.

Application forms from Secretary at College to be returned within 14 days. (485) E9178

NORTH RIDING EDUCATION COMMITTEE

SCARBOROUGH TECHNICAL COLLEGE

ASSISTANTS

Applications are invited for the following posts to take effect from September 1st, 1960.

1. ASSISTANT GRADE "B" for Electrical Installation Courses. Ability to teach elementary Radio an advantage.

2. ASSISTANT GRADE "B" for Machine Shop Engineering and Mechanical Craft Practice Courses.

Forms and particulars available from me on receipt of stamped, addressed envelope. Completed forms to be returned by March 25th, 1960.

F. BARRACLOUGH,
County Hall,
Northallerton. E9180

LONDON COUNTY COUNCIL

WANDSWORTH TECHNICAL COLLEGE

ASSISTANT, GRADE "B"

Wandsworth Technical College require ASSISTANT GRADE "B," to teach Mechanical Engineering subjects to O.N.C. standard Graduate, or equivalent qualifications, industrial and teaching experience desirable. Burnham F.E. Salary Scale £700 by £27 10s. to £1150, plus London allowance, and additions for training and qualifications. Increments within scale for experience. Application forms from Secretary at College, Wandsworth High Street, S.W.18, returnable by 23 March, 1960. (486) E9179

PUBLIC APPOINTMENTS

ADMIRALTY

ROYAL CORPS OF NAVAL CONSTRUCTORS

SCHOOLS ENTRY

A competition for entry into the Royal Corps of Naval Constructors will be held in July, 1960.

2. Accepted candidates will be established as probationers in the Royal Corps of Naval Constructors and will undergo a two-year course of training at the R.N. Engineering College, Manadon, and in H.M. Dockyard, Devonport, followed by a three-year course at the R.N. College, Greenwich.

3. Candidates must be aged between 17 years 6 months and 19 years 6 months, inclusive, at 1st September, 1960.

4. Candidates with the General Certificate of Education will be required to have passed at Advanced Level in at least Pure Mathematics, Applied Mathematics, and Physics taken on the same occasion, and at least Ordinary Level passes in English and a language other than English.

5. Candidates with the Scottish Leaving Certificate will be required to have Higher grade passes in Science (to include Physics), Mathematics, at least two additional mathematical subjects (one of which must be Dynamics), and at least lower grade passes in English and a language other than English. Passes to be gained at not more than two sittings of the Scottish Leaving Certificate examination.

6. Candidates with the Northern Ireland Grammar School Senior Certificate will be required to have passes at Advanced Level in Mathematics (General Course, Pure Mathematics, Applied Mathematics) and Physics—taken on the same occasion ; and at least Ordinary Level passes in English and a language other than English.

7. Applications will be considered from candidates who sit these examinations in 1960.

8. The work of the R.C.N.C. covers all aspects of design, construction and repair to H.M. Ships. Members undertake to serve wherever required at Admiralty headquarters, Outports in the United Kingdom and at Royal Dockyards at home and abroad.

9. The starting pay of a probationer at age 18 will be £545. A deduction of £75 is made when living in at the R.N. Engineering College, Manadon, or at the R.N. College, Greenwich. The successful probationer can expect an appointment as Assistant Constructor at age 23 or 24 with a starting salary of not less than £910 and £940 respectively. Promotion to Constructor normally takes place at about age 30 with a salary which may be expected to be not less than £1515, rising in nine years to not less than £2255. Promotion to higher ranks is by selection.

10. Full particulars may be obtained from the Secretary of the Admiralty, Civil Establishments Branch II(88), Empire Hotel, Bath, quoting reference number 6015, to whom final application must be submitted by 16th May, 1960. E8783

CITY OF NOTTINGHAM WATER DEPARTMENT

APPOINTMENT OF TWO CIVIL ENGINEERING ASSISTANTS

Applications for the above permanent, pensionable appointments are invited from Engineering Graduates and/or Corporate Members of the Institution of Civil Engineers with at least five years' satisfactory experience. Salary dependent upon qualifications and experience, in Grade A.P.T. IV, viz. £1065 by £55 by £50's (2) to £1220.

Applications with names of two persons to whom reference may be made, to Engineer and General Manager, Water Department, Castle Boulevard, Nottingham, not later than 28th March, 1960.

T. J. OWEN,
The Guildhall, Town Clerk.
Nottingham. E9174

BOARD OF GOVERNORS, HAMMERSMITH AND ST. MARK'S HOSPITALS,
DU CANE ROAD, LONDON, W.12

ENGINEERING TECHNICAL ASSISTANT

ENGINEERING TECHNICAL ASSISTANT required. Salary scale (under review) : £725 by £20 (4) by £25 (2) to £855, plus £20/£40 London Allowance.

Further particulars from Secretary. E9133

Classified Advts. continued on page 116

PUBLIC APPOINTMENTS

WORCESTERSHIRE COUNTY COUNCIL

COUNTY SURVEYOR'S DEPARTMENT

RESIDENT ENGINEERS, &c.

Applications are invited for the following appointments, primarily in connection with supervision of contract work on a 28-miles length of the Bristol-Birmingham Motorway, including 63 bridges :

(a) CHIEF PROJECT ENGINEER.
Scale " F " (£1790–£2085).
(b) SENIOR RESIDENT ENGINEERS.
Scale " C " (£1385–£1620).
(c) SENIOR ASSISTANT PROJECT ENGINEER (Land, Accommodation Works, Measurements, Claims).
Scale " B " (£1310–£1485).
(d)(i) SECTION ENGINEERS.
Scale " B " (£1310–£1485).
(ii) SECTION ENGINEERS.
Scale " A " (£1215–£1390).
(e) RESIDENT ENGINEERS (Measurements and Claims).
Scale " A " (£1215–£1390).
(f)(i) ASSISTANT SECTION ENGINEERS.
A.P.T. V (£1220–£1375).
(ii) ASSISTANT SECTION ENGINEERS.
A.P.T. IV (£1065–£1220).
(iii) ASSISTANT SECTION ENGINEERS.
A.P.T. III (£880–£1065).
(g)(i) ASSISTANT RESIDENT ENGINEER (Site Soils Laboratory).
A.P.T. IV (£1065–£1220).
(ii) ASSISTANT RESIDENT ENGINEER (Site Soils Laboratory).
A.P.T. III (£880–£1065).
(h) GRADUATE ASSISTANTS.
A.P.T. I (£610–£765).
(i) LABORATORY TECHNICIANS.
Misc. VI (£715–£775).
(k) DRAUGHTSMEN.
Misc. VI (£715–£775).
(l) CLERKS OF WORKS.
£1000 per annum.
(m) INSPECTORS.
£750 per annum.

The appointments are superannuable, and for a period of approximately two years. Conditions of service are those of the appropriate National Joint Council. " Essential user " scales of car allowances and subsistence allowances at " outside officer " rates will be payable for most of the engineering appointments. Certain site allowances will also be payable for week-end inspections. The County Council will consider the payment of a proportion of furniture removal expenses, and may be able to offer temporary housing accommodation in a few instances.

Candidates for the engineering posts must have had suitable road or bridge design and construction experience, and qualifications proper to the appointment sought.

Graduate Assistants must possess an appropriate Degree, but applications from men now in their final University year would be considered.

Laboratory Technicians should have had appropriate practical experience in the sampling and testing of soils and road materials.

Draughtsmen should be experienced in road and bridge work detailing and should, preferably be conversant with the use of surveying instruments.

Clerks of Works and Inspectors must have had previous experience in these respective positions on large-scale road or bridge contracts.

Previous Local Government experience is not essential for any of the posts.

Applications should be submitted as soon as possible to the County Surveyor, County Buildings, Worcester, in the following form : Appointment and Grade sought ; Name ; Age ; Theoretical Qualifications ; Present Appointment, Grade and Salary ; Previous Appointments and Experience ; Whether car-owning ; When Available ; Particulars of two Referees. (X.23.) E9150

COLNE VALLEY WATER COMPANY

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEER

The Colne Valley Water Company invite applications for the appointment of ASSISTANT MECHANICAL AND ELECTRICAL ENGINEER.

Applicants must have a sound training, with workshop and drawing office experience, and should have a professional qualification.

The appointment will be permanent and pensionable, and the salary range will be from £1015 to £1260 per annum depending upon qualifications and experience. A car allowance will be payable.

Applications should be addressed to :
John Christie, B.Sc., M.I.C.E., M.I.W.E.,
Chief Engineer,
The Colne Valley Water Company,
Aldenham Road,
Watford, Herts,
and should arrive not later than 18th March, 1960. E9138

ADMIRALTY

SHIP DEPARTMENT, BATH

NAVAL ARCHITECTS

Admiralty require NAVAL ARCHITECTS for unestablished posts as SENIOR DESIGN/DESIGN ASSISTANTS in Ship Department, Bath. British subjects with University Degree (or equivalent) in Naval Architecture, and practical shipyard experience. Salaries for two available grades assessed according to age, qualifications and experience, to maxima £2255 and £1330 respectively. Only exceptionally well-qualified candidates considered for higher grade. 5-day week.

Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting C.339/9A. Closing date, 14th April, 1960. E9143

PUBLIC APPOINTMENTS

AIR MINISTRY

ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS

Air Ministry require ASSISTANT MECHANICAL AND ELECTRICAL ENGINEERS, for design, construction and maintenance of installations on airfields, radar stations, missile bases, workshops and maintenance units for R.A.F. at home and overseas as well as certain Civil Airports. Salary : £805 at 25 to £1095 at 34 or over, thereafter rising to maximum £1260, with increase for London and slight decrease for country districts. Appointments non-pensionable but long-term. Promotion prospects 5-day week with 4 weeks 2 days leave a year initially. Special allowance in addition to salary during overseas service.

Qualifications and experience :

(i) (a) University Degree or equivalent Diploma in Electrical and/or Mechanical Engineering with at least 2 years' apprenticeship ; or
(b) Graduate or Corporate Member of I.E.E., with at least 3 years' apprenticeship ; or
(c) Graduate or Corporate Member of I.Mech.E., appreciable electrical engineering experience, with at least 3 years' apprenticeship ; and
(ii) Have been employed for minimum of 2 years with well-established engineering concern and gained wide experience in both electrical and mechanical engineering practice.

Applicants must be natural born British subjects, between ages of 25 and 45.

Forms from Ministry of Labour, Technical and Scientific Register (K), 26, King Street, London, S.W.1, quoting D.158/OA. E9142

GOVERNMENT OF MAURITIUS

FACTORY INSPECTOR AND TRADE TESTING OFFICER

FACTORY INSPECTOR AND TRADE TESTING OFFICER (male, aged 30 to 45) required, to be responsible to Labour Commissioner and to perform duties assigned by Commissioner. Duties to include administration of Factories and Apprentices Ordinances and responsibility of a trade testing scheme. Candidates must possess Corporate Membership of Institution of Mechanical Engineers or Graduateship of Institution or Engineering Degree or Diploma recognised as granting exemption from Associate Membership examination of the Institution, and at least two years' training in industrial mechanical engineering workshops or Corporate Membership or Graduateship of Institution of Engineering, Australia. In the case of candidate possessing latter qualification, he must have had at least two years' practical experience. A working knowledge of French would be an advantage. Post on contract (resettlement grant terms).

Salary scale : £1089–£1665 per annum. Quarters available at low rental. Tour of service 3 years. Low income tax.

Further particulars and application forms from Director of Recruitment, Colonial Office, London, S.W.1, quoting BCD.132/52/04/D4. Candidates should state their full names when applying. E9185

WAR DEPARTMENT

CHESSINGTON

LEADING DESIGN DRAUGHTSMEN

War Department Works Directorate at Chessington require LEADING DESIGN DRAUGHTSMEN (MECHANICAL), especially those experienced in Heating and Ventilating work. Good general engineering background necessary for these posts and successful applicants would be required to work on preparation of heating, air conditioning and ventilating schemes for all types of premises (barracks, housing, workshops, hospitals, schools, offices, canteens, &c.). Applicants, who must be British of British parentage, should have O.N.C. (Mechanical) or equivalent qualification, and also have had at least 4 years' practical and drawing-office experience in planning to tender stage in one or both of the following : (a) low, medium and high pressure hot water heating systems. Steam and condensation systems. Boiler plants. Hot and cold water services. (b) Air conditioning and ventilation systems. Cold stores.

Starting pay (on a scale of £855 to £1055) is based on age, qualifications and experience. Prospects of establishment and promotion. 5-day week of 42 hours, including meal intervals. Canteen facilities.

Apply, stating age and full details of training and experience, to Chief Mechanical and Electrical Engineer, D.G.W., Chessington, Surrey, or to any Employment Exchange, quoting Westminster 698. E9131

NATIONAL RESEARCH COUNCIL, CANADA

DIVISION OF BUILDING RESEARCH

SCIENTIFIC RESEARCH OPPORTUNITY

The Division of Building Research, National Research Council, has an opening for a CHEMIST or CHEMICAL ENGINEER, to assume responsibility for cement and concrete research in the Division. The research studies will embrace studies on the properties and use of concrete materials in well-equipped laboratories located in Ottawa.

Applicants should hold a Master's Degree from a recognised university and have from 3 to 5 years' experience in the cement or concrete field.

Salary will depend on education and experience. Applications and requests for further information should be addressed to :

Employment Officer,
National Research Council,
Ottawa, 2, Ontario,
Canada. E9176

PUBLIC APPOINTMENTS

SOUTHERN RHODESIA GOVERNMENT

VACANCY : INSPECTOR OF MACHINERY

Applications are invited from suitably qualified persons under the age of 42, for a post of INSPECTOR OF MACHINERY in the Factories and Works Inspectorate of the Southern Rhodesia Government Department of Labour. The posts are graded on the Scientific and Technical Officers Grade III, with salary scale of £1280 by £52 10s. to £1700 per annum.

Applicants must be qualified engineers in possession of an approved certificate in Mechanical or Electrical Engineering or the Ministry of Transport First Class Marine Engineers Certificate, and must have had good all-round experience. The duties will include the inspection of all classes of boilers, elevators and general machinery and previous experience in inspection work of this kind, particularly the inspection and testing of Boilers, will be a recommendation.

Application forms and further details from Secretary (R), Rhodesia House, 429, Strand, London, W.C.2. Closing date, March 31st. E9184

NORTH THAMES GAS BOARD, MONCK STREET, WESTMINSTER, S.W.1

DRAUGHTSMAN

DRAUGHTSMAN required by North Thames Gas Board at Monck Street, Westminster, S.W.1, for the Design and Detailing of Reinforced Concrete Structures and Foundations associated with gas works.

Candidates should possess the Higher National Certificate as a minimum qualification, and the starting salary will be according to qualifications and experience.

The appointment will be of a permanent nature, and the successful candidate will be required to join the Board's staff contributory pension scheme.

Applications, stating age, qualifications and experience, should be sent within ten days of the appearance of this advertisement to the Staff Controller, North Thames Gas Board, 30, Kensington Church Street, W.8, quoting reference TE/767. E9177

TENDERS

COMMISSIONERS FOR THE PORT OF CALCUTTA

CHIEF ENGINEER'S DEPARTMENT

TENDER NOTICE

TENDERS are invited from experienced firms for the CONSTRUCTION, SUPPLY and DELIVERY afloat at the Port of Calcutta, in accordance with the specification, contract drawings and the conditions of contract, complete in all respects, for ONE SELF-PROPELLED CUTTER SUCTION AND JET DREDGER, having the length O/A 70ft., Beam MLD. 22ft., and draught 3ft., and capable of suction dredging about 250 tons of solids per hour from a maximum depth of 20ft. and jet dredging about 2000 g.p.m.

Tender documents containing conditions of Tender may be obtained from either the Chief Engineer, Calcutta Port Commissioners, or from the Consulting Engineers, Messrs. Rendel, Palmer and Tritton, on payment of the sum of Rs.40/- or £3 per copy, which is the cost of the documents and which will not be refunded.

The intending Tenderer will have to deposit with the Commissioners' Chief Accountant and Financial Adviser at 15, Strand Road, Calcutta, 1, the sum of Rs.20,000/-, or with Messrs. Coutts and Co., 440, Strand, London, the sum of £1500 to the credit of the Commissioners as earnest money before the submission of the Tender and attach the receipt to the Tender, without which no Tender will be considered. The earnest money has to be deposited in cash ; cheques or Bank Guarantees attached to the Tender will not be accepted. The amount of earnest money will be refunded to unsuccessful Tenderers and in the case of successful Tenderer, this amount will be adjusted towards the security deposit.

Tenders are to be submitted in sealed cover, superscribed " Tender for the Construction, Supply and Delivery of one Cutter Suction Jet Dredger for Calcutta Port "—one copy to be sent to Messrs. Rendel, Palmer and Tritton, 125, Victoria Street, Westminster, London, S.W.1, and two copies to the Chief Engineer, Calcutta Port Commissioners, 15, Strand Road, Calcutta, 1, on the 1st day of July, 1960, so as to reach Messrs. Rendel, Palmer and Tritton not later than 10.30 hours G.M.T. and the Chief Engineer, Calcutta Port Commissioners not later than 16.00 hours I.S.T. on the same day. After this time and date no Tender will be accepted.

Tenders will be opened shortly after the specified time on the same date and any Tenderer who wishes to be present at the time of opening may do so.

The Commissioners do not bind themselves to accept the lowest or any Tender and reserve to themselves the right to reject any Tender without assigning any reasons therefor.

T. M. MALKANI,
Chief Engineer, Calcutta Port Commissioners
The 8th February, 1960.
15, Strand Road,
Calcutta, 1. E9004

EDUCATIONAL

IMPERIAL COLLEGE

BUSARIES in Highway Engineering provided by the Rees Jeffreys Road Fund, tenable from October, 1960. Value from £460 to £760 per annum, including fees.—Further particulars from the Registrar, Imperial College, London, S.W.7. Closing date April 8th, 1960. E9105

TENDERS

CITY OF SHEFFIELD

SEWAGE DISPOSAL DEPARTMENT

BLACKBURN MEADOWS WORKS —RECONSTRUCTIONS AND EXTENSIONS

PHASE II—PRELIMINARY TREATMENT PLANT

CONTRACT NO. B.M.(R.S.) 27— AXIAL FLOW PUMPS

TENDERS are invited for the SUPPLY and DELIVERY of 2 No. Vertical Spindle, Electrically-Driven, AXIAL FLOW PUMPING SETS for screened sewage each having a capacity of 500,000 gallons per hour.

Forms of Tender, Specification, Conditions of Contract, &c., may be obtained from the undersigned on deposit of a fee of £3 3s. which will be refunded when the documents are returned.

Tenders to be delivered to the Town Clerk, Town Hall, Sheffield, 1, not later than 12.00 noon on Friday, 8th April, 1960.

JAS. H. EDMONDSON,
General Manager and Engineer.
Sewage Disposal Department,
Wincobank, Sheffield, 9. E9137

SOUTHPORT AND DISTRICT WATER BOARD

SCARISBRICK WATERWORKS— CONTRACT No. 20

PUMPING PLANT, OIL ENGINE AND ELECTRICAL PLANT, &c

TENDERS are invited from manufacturers for SUPPLYING and ERECTING TWO ELECTRICALLY DRIVEN VERTICAL SPINDLE BOREHOLE PUMPS and THREE SURFACE PUMPS, ONE OIL ENGINE and ALTERNATOR, CRANES, ELECTRIC MOTORS and CONTROL GEAR, &c., at Mill Brow Pumping Station, Southport Road, Scarisbrick, Nr. Ormskirk.

The Tender Form, Conditions of Contract, Specification and Drawings will be supplied by the Engineer and Manager, 14, Portland Street, Southport, on depositing Three Guineas.

Tenders must be delivered to the undersigned at the Town Hall, Southport, not later than first post on Saturday, March 26th, 1960.

R. EDGAR PERRINS,
E9092 Clerk to the Board.

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN FLUID MECHANICS 1960-61

A ONE-YEAR POST-GRADUATE COURSE in " FLUID MECHANICS " will be held at the College during the Autumn, Spring and Summer terms of the academic year 1960-61.

The course is intended for students wishing to acquire a knowledge of fluid mechanics at an advanced level without necessarily specialising in aeronautics. Applicants must be Graduates in a branch of science or engineering and have had practical experience in one of the subjects covered by the course.

The content of the course includes the general theory of fluid flow at subsonic, supersonic and hypersonic speeds, high temperature, gas dynamics and hydromagnetics, project work, experimental facilities and techniques and specialised aspects of ship hydrodynamics (including cavity flows, behaviour of ships at sea and high-powered ship propulsion) and mathematics.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from the Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E8795

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (UNIVERSITY OF LONDON)

POSTGRADUATE COURSE IN NUCLEAR POWER

A full-time postgraduate course in nuclear power is held each year at Imperial College. This course is conducted from the engineering point of view, and is intended primarily for Graduate Engineers and Applied Scientists who wish to pursue a career in the design, development and construction of nuclear power stations. A special feature of the course is the inclusion of a design study of a complete nuclear power project. Experimental work will include the use of a natural uranium-graphite exponential assembly.

Further information may be obtained on application to the REGISTRAR, IMPERIAL COLLEGE, LONDON, S.W.7. E9087

A POST-GRADUATE COURSE IN ENGINEERING STRUCTURES, including Structural Steelwork, will be given in the Civil Engineering Department of Imperial College during the Session 1960–61.

The Course covers the elastic theory of structures, theory of elasticity, theory of plasticity, stability and experimental methods of stress analysis, and comprises lectures, examples, reading assignments and laboratory work.

Post-graduate studentships and bursaries are available for this course, and further particulars may be obtained from the Registrar, Imperial College, London, S.W.7. E9162

EDUCATIONAL

COLLEGE OF AERONAUTICS

ONE-YEAR POST-GRADUATE COURSE IN THE PHYSICS AND MECHANICS OF STRUCTURAL MATERIALS 1960-61

Applications are invited for the ONE-YEAR COURSE which begins on 10th October, 1960. Prospective students must be of Graduate status in an appropriate branch of science or engineering and must have practical experience in one of the fields covered by the course.

The purpose of the course is to give instruction in the analytical methods of the theories of elasticity and plasticity and in the basic theories of the nature of materials derived from the sciences of physics, chemistry and metallurgy.

Students who complete the course satisfactorily will be awarded the Diploma in Advanced Engineering (D.A.E.).

Further information and forms of application may be obtained from : The Warden, The College of Aeronautics, Cranfield, Bletchley, Bucks. E8796 B

A.M.I.MECH.E., B.Sc., City and Guilds, etc. Guarantee Postal Courses for all Exams. and Technical Divisions from Elementary to Degree standard including Automation Techniques. Approximately 95 per cent. successes. 148-page prospectus free, on request.—B.I.E.T. (Dept. 22), 29, Wright's Lane, London, W.8. E114 B

SITUATIONS VACANT

APPLICANTS ARE ADVISED TO SEND COPIES NOT ORIGINALS OF THEIR TESTIMONIALS UNLESS OTHERWISE REQUESTED.

APPLICATIONS ARE INVITED FROM

DESIGN AND DETAIL DRAUGHTSMEN

for general mechanical engineering work in connection with the design and manufacture of chemical works plant. Knowledge of general fabrication, pressure vessels, pipe work and general layout of chemical plant would be advantageous. Permanent positions at good salaries. Staff hostel. Assistance in obtaining houses. Allowance until removal effected. Grant towards removal expenses. Life assurance and Pension Scheme.

Apply in writing to

THE PERSONNEL AND TRAINING MANAGER,
THE POWER GAS CORPORATION LTD.,
STOCKTON-ON-TEES.

E9175 A

APPLICATIONS ARE INVITED from ambitious and resourceful men to fill the position of TECHNICAL ASSISTANT to the Sales Manager of Electric Lamp Machinery Manufacturers near London. A permanent progressive and interesting job is offered to the right person, who must possess a sound engineering and commercial background in the trade.—Applications, with full particulars of education, experience and salary required, to BOX No. E171, "The Engineer." A

ASSISTANT MANAGER wanted for East Coast Scottish firm. Preferably with executive experience in mechanical handling bulk materials and structural work. This is a vacancy with exceptional prospects in an established firm. Replies will be treated in strict confidence. Address to Managing Director.—BOX No. E2752, "The Engineer." A

BRITISH CONCERN having extensive interests in Commonwealth West Africa require an ENGINEER to handle refrigeration and air conditioning. Wide experience of the practical side of this work essential, with the ability to supervise site installations and plant erection, using semi- and unskilled local labour. Design experience would be useful. A good starting salary is offered, coupled with generous allowances and conditions of service. This position is initially for a contract of about 12/18 months but may become permanent. Details of age, qualifications and experience.—BOX No. E9172, "The Engineer." A

CONSETT IRON COMPANY LIMITED
invite applications from
SENIOR ENGINEERING DRAUGHTSMEN

for an interesting and progressive post in a Drawing Office engaged in Development and Maintenance of Coke and By-Product Works and Refractory Brickworks. Mechanical Handling, Purpose-built Machinery, Chemical Plant and Brick Presses are representative of work covered.

The Company operate an attractive pension and assisted house purchase scheme.

Please write to the Personnel Manager, Consett Iron Company Limited, Consett, Co. Durham, giving details of age, education, qualifications and career to date. All applications will be treated in strict confidence.

E9154 A

CEYLON EUROPEAN CONTROLLED COMPANY seek ELECTRICAL ENGINEER. Single preferred, 25–30 years of age, having sound technical and theoretical training. Higher National Certificate essential. Some experience in contracting overhaul and maintenance work. Three-and-half-year contract in first instance. Good salary and prospects.—Write, stating details, &c., to BOX No. Z.O.926, Deacons Advertising, 36, Leadenhall Street, London, E.C.3. E9109 A

CEYLON EUROPEAN CONTROLLED COMPANY seek MECHANICAL ENGINEER with sales experience, for large garage organisation. Single man, aged 25 to 30 years, preferred. Three-and-half-year contract in first instance. Good salary and prospects.—Write, giving details, &c., to BOX No. Z.P.927, Deacons Advertising, 36, Leadenhall Street, London, E.C.3. E9108 A

SITUATIONS VACANT

DRAUGHTSMAN

Applications are invited for the above post, which is located in Birmingham.

The work is interesting and varied and is mainly in connection with the design of industrial heating equipment. A knowledge of combustion technique and the use of refractories would, therefore, be an advantage.

Candidates should possess the Ordinary National Certificate in Mechanical Engineering as a minimum qualification.

The salary for the appointment, which is pensionable and subject to medical examination, will be within the range of £733–£853 per annum.

Applications, stating age, qualifications and experience, together with the names of two referees, should be addressed to the Industrial Relations Officer, West Midlands Gas Board, 6, Augustus Road, Edgbaston ,Birmingham, 15. E180 A

ELECTRONIC AND HYDRAULIC CONTROL OF MACHINE TOOLS

POLLARD BEARINGS LTD., FERRYBRIDGE, KNOTTINGLEY, YORKS., require the services of an ENGINEER with wide experience in the above field.

Please reply, giving full details, to General Manager at the above address.

E9181 A

ENGINEERING OR PHYSICS GRADUATE with experience of electronics, required for research and development on techniques of process control, initially in the field of eddy-current inspection and testing. Applicants should be British subjects, age not over 30. Initial salary, £900 to £1250, according to age and qualifications.—Write, Secretary, B.N.F.M.R.A., Euston Street, London, N.W.1. E9183 A

ENGINEER.—Well-known meat distributors with head office in London have vacancy for young Engineer as ASSISTANT in their Engineering Department. Applicants, preferably not over 30 years of age, must have had drawing-office experience and be familiar with refrigerating requirements in small cold storage depots. Write, giving age and details of qualifications and experience.—BOX No. E9165, "The Engineer." A

HEATING AND VENTILATING ENGINEER required in Westminster office, to deal with site measuring, costs and final accounts. Write, giving full details, including practical experience.—BOX No. E2758, "The Engineer." A

JOHN LAING AND SON LIMITED
require an
ASSISTANT MECHANICAL OR ELECTRICAL ENGINEER

in the Design Office at their Headquarters.

Applicants should be Associate Members or Graduates of their appropriate institution, and have design experience in Mechanical and Electrical Services to buildings.

The post is permanent and progressive. Five-day week. Superannuation scheme.—Apply, stating age, qualifications and experience to Personnel Manager (M.E.S.3), John Laing and Son Limited, London, N.W.7.

E9065 A

MUNICIPAL MUTUAL INSURANCE LIMITED has a vacancy in London for a SURVEYOR to examine cranes and lifting tackle. Technical qualifications : First Class Ministry of Transport or Higher National Certificate. Post is pensionable and permanent to satisfactory candidate who should have served an apprenticeship and have sound practical and theoretical knowledge of cranes and lifting tackle. Salary : £800 to £1000 per annum.—Apply, in own handwriting, marking the envelope "Application Engineer Surveyor" and "Private and Confidential" to the Chief Engineer, 22, Old Queen Street, Westminster, S.W.1. E9140 A

NUCLEAR ENGINEERING

DEVELOPMENT ENGINEERS required for work on novel projects connected with nuclear and conventional steam-generating plant.

Applicants should preferably hold a mechanical or Chemical Engineering Degree and should have some previous experience of the practical aspects in design or development of heat exchangers and high-pressure steam plant.

Commencing salary in range £900–£1200 per annum. Contributory Pension Scheme.

Application should be made in writing, giving details of age, qualifications and experience, to :

Staff Manager,
Foster Wheeler Limited,
3, Ixworth Place,
London, S.W.3.

E9035 A

PRODUCTION ENGINEER.—A highly imaginative, resourceful and skilled practical engineer with considerable experience of time, motion and methods study, and acutely cost-conscious, is required by rapidly expanding Public Company with factories in the London and Midlands areas and with close associations with leading motor manufacturers. Reply, with details of age, status, qualifications, appointments held (with salaries) and experience gained.—BOX No. E2753, "The Engineer." A

PUMP SERVICE ENGINEER for London area required by company supplying centrifugal circulating pumps for central heating systems.—BOX No. E2755, "The Engineer." A

SITUATIONS VACANT

PLANNERS/RATEFIXERS AND ESTIMATORS FOR SOUTH AFRICA

Leading Heavy Engineering Works in South Africa requires Planners/Ratefixers and Estimators. Applicants must have served a fully recognised apprenticeship as Fitters and Turners, and must have thorough experience of this type of work.

Minimum inclusive salary £1150 per annum, but salary will be paid according to qualifications and experience. Good prospects for the right persons.

Housing available. Pension and Medical Benefit Funds. Facilities exist for advancing travelling expenses to South Africa on contract basis.

Write, stating age, qualifications, present salary, previous experience and marital status, to BOX 101, c/o Walter Skinner, Ltd., 20, Copthall Avenue, London, E.C.2. E9136 A

SENIOR DRAUGHTSMAN required by firm specialising in high pressure valve, receiver and compressor design.—Apply to Secretary, Siebe, Gorman and Co., Ltd., Davis Road, Chessington. E2751 A

SPECIAL PURPOSE DESIGN DRAUGHTSMAN

required for Research Engineering unit situated in North West London. Applicants should be over 25 years of age and will be required to show evidence of extensive practical experience coupled with the capability of developing new production techniques including automatic handling. Candidates should be qualified to at least H.N.C. standard. Salary in the range £1100 per annum or upwards, depending on ability and experience.

Applications will be treated in strict confidence, and should be made in writing to SP 1921, A.K. Advg., 212a, Shaftesbury Avenue, London, W.C.2. E9054 A

TECALEMIT LIMITED, PLYMOUTH, DEVON

have a vacancy for a SENIOR ASSISTANT in the Physical Laboratory of the Research Department.

The work involves research and control on non-metallic materials such as filter media, plastics, rubber and adhesives.

Applicants should have a University Degree in Mechanical Engineering or equivalent qualification, with an interest in physics or technology ; research experience with one of the materials mentioned and some experience in statistics as applied to planning and evaluating experimental work will be an advantage.

The finally selected candidate will find interesting and varied work as the leader of a team in a progressive and active modern factory. His salary will be commensurate with his qualifications and experience.

The Company operates a contributory superannuation and life insurance scheme.

Applications should include details of age, education and experience, and be addressed to the Employment Officer. E2750 A

TECHNICAL ASSISTANT for Sales Office engaged in tendering and executing contracts for transmission line insulation. Qualifications : Higher National Certificate in either Electrical or Mechanical Engineering. Previous tendering experience and ability to handle correspondence desirable but not essential.—Applications should be addressed to the Personnel Officer (Staff), Pilkington Brothers Limited, St. Helens, Lancashire. E9125 A

TECHNICAL SALES ENGINEER required by leading Pump Manufacturers on their London Office Marine Sales Staff. Should have sales and sea experience, with knowledge of condensing, closed-feed systems and compressed air applications. Apply, stating qualifications and salary required.—BOX No. E9090, "The Engineer." A

THE UNITED AFRICA COMPANY requires a SENIOR MECHANICAL ENGINEER with a distinct practical bent for their large Sawmill and Plywood Mill at Sapele, Nigeria. He will be responsible under the Chief Engineer for the maintenance of the Saw Milling and Plywood Manufacturing Plant, Steam and Diesel Power House, and all services, and will be in control of a team of Mechanical Maintenance Supervisors. He will also be required to deputise for the Chief Engineer on U.K. leaves Age limit 37 years. Minimum qualifications, First Class Mechanical Engineering Apprenticeship, Higher National Certificate in Mechanical Engineering and several years' experience in the maintenance of heavy industrial plant. An exacting and interesting appointment, well paid with good prospects of promotion. Tours are about eighteen months. Good home leave. Free furnished accommodation in West Africa. Free passages and contributory Pension Fund.—Apply to Manager, Staff Department, United Africa Company Limited, P.O. Box 1, Blackfriars Road, London, S.E.1. E9141 A

THE UNITED AFRICA COMPANY require a MECHANICAL ENGINEERING DRAUGHTSMAN for their sawmill and plywood manufacturing plant at Sapele, Nigeria, for the preparation of layout and detailed drawings, cost estimates for mechanical, electrical and building work, associated with plant development and maintenance. Minimum qualifications are O.N.C. (Mechanical) and several years' drawing-office experience. A trade apprenticeship would be of distinct additional value. Preferred age 23/25. Minimum starting salary £950 per annum, with free furnished accommodation and passages. Tours approximately 20 months with one-fifth tour U.K. leave on full pay. Family allowances are payable and there is a contributory pension fund. This appointment offers unusually good prospects for promotion.—Apply, with full particulars, to : The Manager, Staff Department, United Africa Company, United Africa House, Blackfriars Road, London, S.E.1. E9144 A

SITUATIONS VACANT

THE BOWATER PAPER CORPORATION LIMITED, Engineering Division, require the services of a qualified POWER ENGINEER for technical duties in connection with Industrial Power Plant. The applicant should have practical experience in the operation of modern Boiler House and Turbine House equipment and the maintenance of High Pressure Plant. He should also be familiar with the calculations necessary for thermal cycle comparisons in connection with new projects. The qualifications required are Graduate or Corporate membership of the Institution of Mechanical Engineers or the Higher National Certificate in Engineering.—Applications, giving full details of qualifications, previous experience and salary required, should be addressed to The Chief Engineer, The Bowater Paper Corporation Limited, Engineering Division, Northfleet, Kent. E9113 A

THE HARLAND ENGINEERING CO. LTD., manufacturers of medium/heavy electrical and hydraulic machinery, invites applications for the post of APPRENTICE TRAINING SUPERVISOR. The position is a new one, and will involve reorganising and extending the existing Apprentice Training Centre ; instructing apprentices by classroom lectures and demonstrations ; planning movement of apprentices throughout the Factory ; and giving advice and encouragement on courses of external study. Remuneration will be in accordance with qualifications. Staff Superannuation Scheme. —Applications, stating age, qualifications, experience in chronological order, and salary expected, should be addressed to the Personnel Manager, Harland Engineering Co. Ltd., Alloa, Scotland. E9139 A

TOOL AND MACHINE TOOLMAKERS

required for Methods Development workshop of large-scale light engineering organisation in North West London. Applicants should have experience in the manufacture and tryout of special purpose equipment associated with the production of components and automatic assembly in the field of instruments and light mechanism.

Applicants will be treated in strict confidence and should be addressed to Box TA 1951, A.K. Advertising, 212a, Shaftesbury Avenue, London, W.C.2. E9160 A

WANTED, FIRST-CLASS SENIOR DESIGN DRAUGHTSMAN for firm of General Engineers in Bristol. Good knowledge of general engineering, with particular reference to pressure vessels and stainless steel fabrication. This will be a well-paid position for the top-class man.—BOX No. E164, "The Engineer." A

YOUNG ENGINEER required as BOILER SALES REPRESENTATIVE for London office. Age about 30. Experience on boilers and combustion equipment essential ; adaptable, enthusiastic. Salary will reflect experience and knowledge and there is a generous pension scheme.—Apply, Staff Manager, Ruston and Hornsby, Ltd., Waterside South, Lincoln. E9161 A

ELECTRICAL ENGINEERS

Electrical Engineers are required by one of the leading manufacturers of Iron and Steel, to assist with the electrical engineering side of a large development programme. Candidates must have a good theoretical background and possess a degree or an equivalent qualification. Wide practical experience in manufacturing industry an advantage. Experience in iron and steel industry and particularly on Continuous Mills would be an asset.

Terms of service and other conditions are attractive and the housing situation is good. There is a Staff Pension Fund and Life Assurance Scheme.

Applications will be treated in complete confidence, and should be addressed to BOX No. E9149, "The Engineer."

A

CANADA

One of the world's leading manufacturers of gas turbines seeks a dynamic

SENIOR EXECUTIVE

with a degree in mechanical engineering and at least 10 years experience in the field of

INDUSTRIAL GAS TURBINES

This is an administrative position carrying wide responsibilities and a corresponding remuneration, pension scheme, sickness insurance, etc. Passage paid by employer. U. K. interviews can be arranged immediately. Please send full particulars to BOX No. E2757, "The Engineer."

A

Classified Advts. continued on page 118

SITUATIONS VACANT

DESIGN ENGINEER

A vacancy occurs in the Mechanical Design Section of the Process Plants Division of Foster Wheeler Ltd. The work involves the mechanical design of Heat Exchangers, Pressure Vessels, Process Piping (including thermal analysis), and the various special problems which arise in the design of Oil Refinery and Chemical Plant. Preference given to a Graduate Engineer having a minimum of two years' industrial experience, versatile, and with an aptitude for design. The position provides a wide range of interest, with full scope for original work in an integrated group. Salary will be commensurate with qualifications and experience. Pension and Life Assurance Scheme.—Write fully, age, qualifications and experience to Foster Wheeler Ltd., 3, Ixworth Place, London, S.W.3.

E9145 A

SITUATIONS VACANT

TECHNICAL PUBLICATION

Applications invited for appointment of a suitably qualified man to manage production of a technical publication in London. The work involves planning an improved type of publication, obtaining and writing articles on such subjects as (*a*) the historical aspects of engineers and engineering achievements; (*b*) recent engineering developments in selected fields and (*c*) possible future trends of engineering science. Applicants with a university degree or Diploma in Mechanical Engineering, and membership of a Professional Engineering Institution will receive special consideration. Age range 35-45 years. Superannuation provision. Salary in accordance with qualifications and general personal qualities.—Application, with details of experience, to BOX No. E9151, "The Engineer."

A

SITUATIONS VACANT

ROLLING MILL ENGINEER

A leading United Kingdom Iron and Steel Company requires an Engineer to take control of the Rolling Mill Section of its current large development programme. This is an important position, offering great scope for initiative and requires an Engineer with special qualifications and ability. A sound design and operational background in this field is essential.

Terms of service and other conditions are attractive and the housing situation is good. There is a Staff Pension Fund and Life Assurance Scheme.

Applications, which will be treated as confidential, should be sent to BOX No. E9146, "The Engineer."

A

SITUATIONS VACANT

PLANNING TECHNICIAN

required by

THE ATOMIC WEAPONS RESEARCH ESTABLISHMENT,

FOULNESS, ESSEX

to be employed under a senior member of the technical staff, on the planning, estimating and progressing of precision engineering work. Candidates should have served a recognised apprenticeship or have had equivalent training. They should have a detailed knowledge of planning for a light/medium machine shop, welding, sheet metal and ancillary workshops, together with a knowledge of simple contract procedure, and progress systems suitable for this class of work. Possession of an O.N.C. in mechanical engineering is desirable.

Salary: £925–£1105.

Superannuation Scheme. Housing, House Purchase and Hostel facilities.

Write for application form to the Senior Recruitment Officer, A.W.R.E., Aldermaston, Berks.

Please quote ref. 2567/25.

E9155 A

AIC **Executive Selection Service** *is advising on the following appointment*

ACCOUNTANTS (Consultants)

Associated Industrial Consultants Limited require accountants between 28 and 38 years of age for work in the United Kingdom, British Commonwealth and Europe. Full professional qualifications are essential. In addition, experience of at least five years in a managerial capacity is required. Selected applicants will be trained at the Company's College of Management and the posts carry an initial salary of approximately £1700 per annum with opportunity for regular increases to £2700. In addition there are superannuation contributions and expense reimbursements by the Company and opportunities for promotion to senior positions with considerable advancement of salary. Special consideration will be given to those wishing to reside in Ireland and Scotland, and to those who are fluent in French, German or Italian.

A brief statement of qualifications and experience should be sent to the Personnel Secretary, marked (ENG) 422/3, at

All applications will be treated in confidence.

Associated Industrial Consultants Limited BUSH HOUSE LONDON WC2

E9132 A

DRAUGHTSMEN/ DESIGNERS

THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED

have vacancies for

Mechanical and Structural Engineering Draughtsmen, required for design, layout and detail work on Steelworks Plant and Industrial Furnaces. Attractive salaries offered to men possessing ability and initiative. Contributory Pension Scheme. Five-day week. Holiday arrangements for this year can be mutually agreed.

Application, in confidence, giving details of education, training and experience, should be forwarded to :—

GENERAL MANAGER,
FURNACE DIVISION,
THE WELLMAN SMITH OWEN ENGINEERING CORPORATION LIMITED,
WILTON ROAD,
LONDON, S.W.1.

E9168 A

SHELL **SHELL-MEX AND B.P. LTD.** BP

have vacancies in the U.K. for

QUALIFIED ENGINEERS

Candidates should have had thorough training in workshops and possess either Corporate Membership of the Institutions of Civil or Mechanical Engineers or have passed parts A and B of one of these Institutions' examinations or have qualifications entitling them to exemption from such examinations. Experience on pumps and pipelines or building construction would be advantageous.

Conditions of employment are excellent and there is a good Pension Scheme. Starting salary will depend entirely on qualifications and experience. Replies, marked Ref. CA/85, should be sent to :—

The Staff Manager, Shell-Mex and B.P. Ltd.
Staff Dept., Shell-Mex House, Strand, W.C.2.

E9130 A

AEI

Qualified

FACTORY SERVICES ENGINEER

for service in India

Applicants must have a wide knowledge and experience of the works services, and service equipment appropriate to large engineering factories, e.g. compressed air—steam—oxygen, acetylene, dust and fume extraction, ventilation, air conditioning, etc. A comprehensive knowledge of modern practices in safety precautions, safe methods of operation and factory act requirements would be advantageous.

The ability to write tight and clear specifications for plant and services, and to examine and report on tenders is essential and also to supervise erection, make clear progress reports and check unacceptable work.

Three-year contract in the first instance. Salary up to £2400, free housing and services, free medical attention, use of car, first-class passages each way for engineer and family, and other valuable advantages.

Apply, stating age, technical qualifications, experience, family circumstances and names of references, to :

Secretary, A.E.I. Overseas, Ltd.,
33, Grosvenor Place, S.W.1.

E9147 A

ATOMIC ENERGY RESEARCH ESTABLISHMENT

HARWELL

offers excellent opportunities for

DESIGN ENGINEERS

to design NUCLEAR PHYSICS EQUIPMENT for NIMROD, the 7 GeV PROTON SYNCHROTRON now under construction for the NATIONAL INSTITUTE FOR RESEARCH IN NUCLEAR SCIENCE.

The posts call for

MECHANICAL DESIGN ENGINEERS

Corporate membership I.M.E. or equivalent qualifications. Experience in mechanical engineering design.

ELECTRICAL DESIGN ENGINEERS

Corporate membership I.E.E. or equivalent qualifications. Design experience of a variety of electrical work.

ASSISTANT DESIGN ENGINEERS

Apprenticeship, H.N.C. or equivalent Mechanical engineering design experience, or experience of electrical control systems and light current electrical equipment.

Salary: £860–£1,825 p.a., starting salary according to age, qualifications and experience.

Send POSTCARD for details and application form to the Group Recruitment Officer (1606/25), U.K.A.E.A., A.E.R.E., Harwell, Didcot, Berks.

E9164 A

SITUATIONS VACANT

PLANT ENGINEER

A Plant Engineer is required, to take complete charge of maintenance and installation of all equipment in modern mechanised Foundry. The Foundry consists principally of 4 reasonably large mechanised systems and these are already in charge of good Maintenance Foremen. The successful applicant will be a qualified man able to supervise the maintenance force, concentrating on preventative maintenance.

He should preferably be familiar with mechanised Foundry equipment, although this is not essential if a good engineering background is there.

Salary envisaged: £1800 per annum, with good Pension Scheme. Housing available.—BOX No. E9169, "The Engineer." A

SITUATIONS VACANT

PRODUCTION ENGINEER

New position in King's Norton area. Qualifications: apprenticeship and H.N.C. (Prod. or Mech.), minimum experience, used to small batch Production in Machine Tool field. Knowledge of Mass Production an advantage. Full experience of Planning, Tooling, Work Study; also good administrative ability essential.

Apply in writing, giving full details of experience, age and salary required.—BOX No. E9173, "The Engineer." A

SITUATIONS VACANT

ROBERT WATSON & CO.
(Constructional Engineers)
LTD.,
BOLTON

Invite applications for the appointment of

CHIEF DESIGNER

This vacancy provides an excellent opportunity for a first-class engineer possessing the necessary drive, initiative and organising ability.

Candidates should have an engineering degree or have attained A.M.I.Struct.E. standard and should be

(1) Capable of designing and estimating for all classes of structural steelwork contracts.
(2) Conversant with modern techniques and drawing office management, and
(3) Preferably in the age group 35 to 50.

Knowledge of welded platework would be an advantage.

An attractive salary and pension rights will be offered to the suitable applicant. Applications, which will be treated in strict confidence, should contain full details of age, qualifications and past experience, and be addressed to the

MANAGING DIRECTOR

E9156 A

SITUATIONS VACANT

Royal Air Force Technical Branch

Men and women under 37 who hold the H.N.D., H.N.C. (or equivalent qualification) in Mechanical or Electrical Engineering and a G.C.E. with a pass at "O" level in English Language are invited to apply for a short service commission of 5 years in the Technical Branch of the Royal Air Force.

Selected candidates will be required to carry out a course of officer training followed by some specialist training to fit them for duties in the Technical Branch. Promotion to Flight Lieutenant can be expected after five years' commissioned service and there are opportunities for appointments to permanent commissions.

For full details, including particulars of pay increases and improved pensions, write to: Air Ministry (M.9), (EJA596), Adastral House, London, W.C.1.

E9129 A

HERBERT MORRIS LIMITED
Loughborough

have vacancies for

GENERAL MECHANICAL ENGINEERING DRAUGHTSMEN

who wish to join a mechanical handling company with a varied and interesting range of products. All applicants with sound engineering experience will be considered. Experience in mechanical handling would be an advantage.

Where necessary, assistance can be given with housing.

Interviews can be arranged to suit applicants' convenience.

Write particulars age, previous experience, and any qualifications, such as O.N.C., to the Personnel Manager.

E9068 A

GRADUATE MEMBERS OF THE INSTITUTION OF ELECTRICAL ENGINEERS

are invited to apply for the position of

ELECTRICAL DRAUGHTSMAN

at Pilkington Brothers Limited, Cowley Hill Works, St. Helens.

The appointment is to organise and control an Electrical Drawing Office. The position involves the preparations of specifications, drawings and estimates for H.V. and M.V. electrical distribution schemes, illumination and equipment for industrial plant and buildings in a Works with a maximum demand of 15,000 K.V.A.

Assistance with house purchase, canteen and recreation facilities, five-day week, superannuation scheme.

Application should be made, giving details of age, qualifications and experience, to:

The Works Personnel Officer,
PILKINGTON BROTHERS LIMITED
Cowley Hill Works, St. Helens, Lancashire

E9182 A

JOSEPH LUCAS (ELECTRICAL), LIMITED

There are vacancies for

DESIGNERS & DRAUGHTSMEN FOR LIGHTING DEPARTMENT

to work on mechanical design of a wide range of lamps for new car models. The work involves the application of pressure diecasting, pressing and plastic moulding techniques for large quantity production and some experience in one of these fields would be an advantage.

Applicants should have Higher National Certificate, but consideration will be given to men with Ordinary National Certificate and suitable experience. The posts are permanent and pensionable, and a good starting salary will be paid. Five-day week.

Apply in writing, stating age, qualifications and experience to the Personnel Manager, JOSEPH LUCAS (ELECTRICAL), LIMITED, Great King Street, Birmingham, 19, quoting reference PM/D/420.

E9123 A

A National Electrical Service
Northern Electric

OFFERS

JOB SECURITY TO MACHINE, TOOL AND GAUGE DESIGNERS

Experienced design personnel are required for high-class, complex, tool and machine design assignments, together with die and fixture design as required for the production of a complete range of telecommunications and wire and cable products.

These positions are located in the Montreal area. The Company, established in 1895, has recruited technical personnel in the United Kingdom for more than seven years. In the last 20 years no technical personnel have been laid off because of recessions.

Senior design personnel with appropriate training and experience will be interviewed in Great Britain during late March. Transportation allowance for successful applicants. Give full details in first letter to:

Dept. N.E.C.,
National Employment Service—Canada,
61, Green Street,
LONDON, W.1.

E9134 A

RTB

RICHARD THOMAS & BALDWINS LIMITED

SPENCER WORKS

LLANWERN, Nr. NEWPORT, MON.

CHIEF ENGINEER

A CHIEF ENGINEER is required for the new integrated steelworks at present under construction at Llanwern, Nr. Newport, Mon.

The successful candidate will not be responsible for the construction of the new works, but will be responsible to the General Manager for all the engineering and maintenance services under operating conditions, and will take part in the planning and supervision of future development of the plant. When the first stage of operations begins, he will have about 2500 men under his control.

Applicants must be highly-qualified engineers and have held a senior position, preferably in the iron and steel industry or a related industry.

This is a senior management appointment, and the salary will be commensurate with its responsibility.

Applications should be made to the:—

Director and General Manager,
RICHARD THOMAS & BALDWINS LIMITED,
Spencer Works, Llanwern, Nr. Newport, Mon.
before March 23, 1960.

E9124 A

Classified Advts. continued on page 120

SITUATIONS VACANT

'ENGLISH ELECTRIC'

AVIATION LIMITED

AIRCRAFT DIVISION · LYTHAM ST. ANNES

Now is the time to secure your future in the NEW AIRCRAFT INDUSTRY with responsibilities in developing the new generation of Civil Aircraft backed by extensive Military Contracts, including considerable development of the Lightning and the new T.S.R.2. There is probably a post with increased responsibilities for you in one of the following categories:—

MECHANICAL ENGINEERS

- Structural Design, Stress Analysis, Airworthiness.
- Internal Flow and heat transfer.
- Development of mechanical systems.
- Aeroelasticity.
- Development Engineers.
- Weight Control Engineers.

AERODYNAMICISTS & MATHEMATICIANS

- Flight Test engineers with a minimum qualification to H.N.C. level.
- Computer Programmers.
- Aerodynamicists for control stability and performance calculations.
- Fluid flow specialists.
- High speed wind tunnel engineers.

ELECTRICAL ENGINEERS

- Theoretical Design of aircraft electrical systems.
- Development of electrical components.
- Development of Automatic Flight Systems.
- Electronic Engineers for development of " one off " control systems.
- Electrical and Electronic technicians to operate comprehensive test rigs.

AIRCRAFT DESIGN DRAUGHTSMEN

- For these vacancies applicants must have 3 years' experience in an aircraft D.O. and be engaged on design work.
- Electrical installations.
- Engine equipment and control installations.
- Structural design and engine installation.
- Power controls.
- Mechanical design, e.g. undercarriage design, control boxes, escape facilities.
- Flight test instrumentation.

If you are interested in one of these subjects and would like to make an appointment to discuss these opportunities on an informal basis, we invite you to write in confidence to Dept. C.P.S., Marconi House, 336/7, Strand, W.C.2., quoting reference E 1716C; giving details of your qualifications and experience and indicating your particular interest.

Appointments will be arranged by the Aircraft Division to suit your convenience, and we will endeavour to meet you at a centre within easy access to your home.

All appointments will be permanent and pensionable, after a qualifying period, and assistance with removals and housing will be given in certain cases.

E9078 A

SITUATIONS VACANT

MANAGEMENT CONSULTANTS

QUALIFIED ENGINEERS with personality and drive are offered extremely interesting work covering a wide range of industrial problems, and giving experience, remuneration and status equal to senior executive positions in industry. There is ample scope for advancement and service abroad if desired.

The work includes the development and introduction of :—

Factory layout, mechanical handling and automation.
General organisation and production control.
Purchasing, stock control and stores organisation.
Planning engineering, methods and work study.
Incentives, training and personnel administration.
General business and project surveys in a wide range of industries and often in conjunction with marketing, technical or financial consultants.

Applicants should be aged 26–35 years with a good general education and university degree or equivalent qualifications. The starting salary and remuneration arrangements include a generous non-contributory superannuation, life assurance and share of profits. Replies, which will be treated in confidence, should be addressed to :

Reference QG

PRODUCTION-ENGINEERING, LTD.,
12, Grosvenor Place,
London, S.W.1. E9153 A

AEI

QUALIFIED ENGINEER

for service in India

Wide knowledge and experience of the machine tools and tooling used in the medium/heavy engineering industry essential.

Applicants should have a knowledge of British, Continental and American machine tools, and be able to inspect and report on suitability, accuracy and workmanship of any manufacturer's machine in relation to a specific production requirement. He must also be able to inspect machines and equipment on arrival on site for completeness, or damage ; to supervise installation and lining up, and the commissioning of machines and their tooling for specific jobs.

Three-year contract in first instance. Salary up to £2400, free housing and services, free medical attention, use of car, first-class passages each way for engineer and family and other valuable advantages.

Apply, stating age, qualifications, experience, family circumstances and names of references, to :—

Secretary, A.E.I. Overseas, Ltd.,
33, Grosvenor Place, S.W.1. E9148 A

MECHANICAL ENGINEER-DESIGNER

required by

SIR ROBERT McALPINE & SONS LTD.

to work from their London Office.

Experience in Civil Engineering Plant preferred, but not essential. Minimum standard H.N.C.

Age about 35.

Salary according to experience.

Bonus payable.

Apply, in writing, to
80 PARK LANE, LONDON, W.1.
E9152 A

GOSS OF PRESTON

GOSS PRINTING PRESS COMPANY LIMITED, manufacturers of large printing presses, have immediate vacancies for

3 SENIOR DRAUGHTSMEN

These vacancies are due to the Company expanding, resulting in numerous promotions.

The successful applicants should have experience in the design of Machine Tools. At least Ordinary National Certificate qualification is a necessity.

Excellent conditions of employment, including 5-day week, Pension and Life Assurance Scheme, Annual Bonus.

Applications, stating full details of age, experience and qualifications, to be addressed to the

PERSONNEL MANAGER,
Greenbank Street,
PRESTON (Telephone No. 57571),
Quoting Ref. No. PD 84.
E9186 A

SITUATIONS WANTED

STRUCTURAL WORKS MANAGER, shortly returning to U.K., requires employment. Experienced all types of steel fabrication. Anything considered, anywhere. Commissions in India or en route to U.K. also welcomed.—BOX No. E2741, "The Engineer." B

ENGINEER, A.M.I.Mar.E., M.O.T. 1st Class Combined experience. High-rated steam and diesel power plants, all types, plant installation, steel erection, heavy foundation work, workshops. Willing to travel anywhere. Good personality. Hard worker. Age 34. Any progressive concern.—BOX No. E2754, "The Engineer." B

FOR HIRE

LATTICE STEEL ERECTION MASTS (light and heavy), 30ft. to 150ft. high, for immediate hire.—Bellman's, 21, Hobart House, Grosvenor Place, S.W.1. E103 K

600

FORK LIFT TRUCKS FOR HIRE

Modern Machines Only
Diesel & Battery/Electric
Capacities 2000 lb-18,000 lb
Contact your nearest Depot :

GEORGE COHEN,
SONS & CO. LTD.
WOOD LANE, LONDON, W.12.
(Shepherds Bush 2070)
And at Stanningley (Nr. Leeds) . Kingsbury (Nr. Tamworth) . Manchester . Glasgow Swansea . Newcastle . Belfast . Sheffield Southampton . Bath
E200 K

MISCELLANEOUS

DAVIES INVESTMENTS LTD.,
BANKERS
Continue to offer 7½ per cent. on sums £20-£500 (withdrawal on demand) with extra ½ per cent. on each £500 unit.
Details and Audited Balance Sheet from Investment Dept. ER,
DAVIES INVESTMENTS LTD.,
DANES INN HOUSE, 265, STRAND,
LONDON, W.C.2.
E178 I

MOBILE LIFTING SERVICES.—Lump sum or Hire Rate Quoted for any Lifting Work by Lorry-Mounted or Crawler Cranes, any size, any area.—TARSLAG, LTD., Rotherham 3235. E166 I

BUSINESSES & PREMISES

COVENTRY

(Close City Centre and Main Line Railway Station)

SINGLE STOREY FACTORY

71,000 Sq. Ft.

Freehold for Sale

Part north lighted. Central Heating.
Loading Bay. Good Yard Space.
Travelling Cranes in one section.
12,000 ft. Cost of Works War Damage Payment outstanding.

Particulars of :

HENRY BUTCHER AND CO.,
73, Chancery Lane, London, W.C.2. *Tel.* : HOLborn 8411.
E9163 L

AGENCIES

ENGINEER, at present with well-known Consultants, now intends to establish an AGENCY in N.E. Coast area, and would be pleased to act for companies engaged on design and manufacture of Power Plant, Colliery Surface Plant and Harbour Installations, including Bulk Handling of Materials. —BOX No. E2756, "The Engineer." D

SUB-CONTRACTING

KELLERING AND CAM PROFILING capacity up to 8ft. by 6ft. or 6ft. diameter.—ARMYTAGE BROS. (KNOTTINGLEY), Ltd., The Foundry, Knottingley, Yorkshire (Telephone : Knottingley 2743/4). E116 MW

PRATCHITT BROTHERS, LTD., Denton Iron Works, Carlisle, having well-equipped engineering shops and ironfoundry, invite enquiries for General Engineering, Structural and Platework, from firms wishing to have plant made to their own designs and specifications. E751 MW

LONDON SHEET METAL WORKS—Mainly engaged in manufacture of Metal Containers and Boxes—require Additional Work. Well-equipped workshops—spot welder—80-ton power press. At present engaged on tinplate can production. Enquiries invited.—BOX No. E2759, "The Engineer." MW

G·I·C

GLOBAL INDUSTRIAL CONSULTANTS LTD.
SHEERWATER WOKING SURREY

EXPERTS *in the* DESIGN *and* MANUFACTURE *of special purpose* MACHINES

INVITE YOUR ENQUIRIES

Telephone
WOKING 4680-4
E2723 MW

PATENTS

THE PROPRIETORS of British Patent No. 775,447, for "IMPROVEMENTS IN AND RELATING TO A MOULD AND METHOD FOR MAKING FEED ROLLS FOR STAMP VENDING MACHINES," are desirous of entering into negotiations with firms in this country for the purpose of exploiting the above invention, either by Sale of the Patent Rights or by granting of Licences to Manufacture on a royalty basis.—Enquiries should be addressed to Abel and Imray, Quality House, Quality Court, Chancery Lane, London, W.C.2. E9126 H

THE PROPRIETORS of British Patent No. 775,448, for "IMPROVEMENTS IN AND RELATING TO FEED ROLLS FOR STAMP VENDING MACHINES," are desirous of entering into negotiations with firms in this country for the purpose of exploiting the above invention either by Sale of the Patent Rights or by granting of Licences to Manufacture on a royalty basis.—Enquiries should be addressed to Abel and Imray, Quality House, Quality Court, Chancery Lane, London, W.C.2. E9127 H

THE PROPRIETOR of British Patent No. 685,723, entitled "SPRING FORMING MACHINE," offers same for License or otherwise, to ensure practical working in Great Britain.—Enquiries to Singer, Stern and Carlberg, 14, E. Jackson Blvd., Chicago, 4, Illinois, U.S.A. E9187 H

PATENTS

THE PROPRIETORS of British Patent No. 763,619, for "IMPROVEMENTS IN AND RELATING TO INTERNAL COMBUSTION ENGINES AND EXHAUST GAS SILENCERS THEREFOR" are desirous of entering into negotiations with firms in this country for the purpose of exploiting the above invention, either by Sale of the Patent Rights or by granting of Licences to Manufacture on a royalty basis.—Enquiries should be addressed to Abel and Imray, Quality House, Quality Court, Chancery Lane, London, W.C.2. E9128 H

MACHINERY Etc. WANTED

URGENTLY REQUIRED

3-MOTOR ELECTRIC DERRICK CRANE.
With 100ft. jib. To lift 8 tons at a minimum of 65ft. radius. Second-hand.
Details.—BOX No. E107, "The Engineer." F

WANTED, SECOND-HAND HERBERT FLASHCAP LATHES, No. 2, Type LS, 7B and 9B.—BOX No. E2749, "The Engineer." F

FOR SALE

SERVICE EDWARDS VALUE!

PELS Type 30 **BLUEFG** Power-Geared Universal Punching, Shearing and Section Cropping Machine, balanced drive, motorised for 400/3/50, depth of gap 30in., punches holes up to 1 ¼in., plate up to 1 ¼in., flat bars up to 4½in. by 1 ¼in., &c., length of blades 16in., weight approximately 10 tons.

BESCO Double-Geared Hand-Operated Universal Swing Beam Folding Machine, capacity 6ft. 2in. by ¼in. thick, smallest trunk round beam 8½in. by 7½in.

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Classified Advts. continued on page 122

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		Main Location	*Auctioneers*
March 15	Miscellaneous stores, including:—	Central Ordnance Depot, Didcot, Berks.	SIMMONS & SONS, (Dept. L), 12, Station Road, Reading, Berks. (Tel.: 54025.)
	Drills; spanners and extension bars; chisels; hammers; pliers; tool rolls; tool chests; screws; nuts; bolts; wire; block tackle and lifting gear; pallets; fire fighting equipment; cartons; cases; enamelware; camping equipment; tarpaulin and cotton covers; sleeping bags; haversacks; webbing; canvas water bags; paint; iron weights; etc.		
March 15-18	Vehicles, earth moving and lifting equipment, including:—	M.O.A. Storage Depot, Ruddington, Notts.	WALKER, WALTON & HANSON (Dept. L), Byard Lane, Bridlesmith Gate, Nottingham. (Tel.: 54272.)
	1800 motor vehicles, trailers, motor cycles, etc., including 280 Saloons, limousines and estate cars by Austin, Ford, Hillman, Humber, Morris, Standard, Vauxhall and Wolseley (including 111 Ford Anglias, Populars, and Morris Minors); Austin "Champs"; Land Rovers; coaches; vans; tippers; other load carriers and dual purpose vehicles (many fitted with Diesel engines); trailers; 10 cwts.–10 tons; tankers 100 galls. to 2500 galls.; excavators by Koehring and Ruston Bucyrus; mobile cranes (some lorry mounted) by A.E.C., Coles, Hyster, Jones, Lorain, Neals, Ransomes & Rapier; crawler tractors, angledozers, and bulldozers by Caterpillar (including "D4's," "D7's" & "D8's") scrapers; dumpers; Chaseside "Hi-Lift" shovels; cable laying ploughs; Aveling Barford road roller; Bedford Lewin sweeper; fitted mobile workshops; trailer mounted fire pumps; wheeled tractors; Stothert & Pitt Diesel cement mixer; Holman trailer mounted air compressor; special Bedford 10-ton Diesel tractor; 300 solo and combination motor cycles by Ariel, Douglas (Vespa) James, Matchless, and Norton, plant ancillaries and spares by Caterpillar, Barber Greene, Bucyrus, General, Hyster, Jones, etc.		
March 22-24	Vehicles, machine tools and miscellaneous stores.	Central Ordnance Depot, Bicester, Oxon.	MIDLAND MARTS, LTD (Dept. L), Market Square, Bicester, Oxon. (Tel.: 73.)
March 30	Miscellaneous stores.	Northern Command Ordnance Sub-Depot, Barlow, Nr. Selby, Yorks.	BARTLE & SON (Dept. L), 50–52, Merrion Street, Leeds, 2. (Tel.: 2.0898.)
April 8	Miscellaneous stores.	Returned Stores Group, Reed Hall, Colchester, Essex.	FENN, WRIGHT & CO., (Dept. L), 146, High Street, Colchester, Essex. (Tel.: 3171.)
April 21	Miscellaneous stores.	M.O.A. Storage Depot, Rotherwas, Hereford.	RUSSELL, BALDWIN & BRIGHT, LTD. (Dept. L), 20, King Street, Hereford. (Tel.: 4366.)

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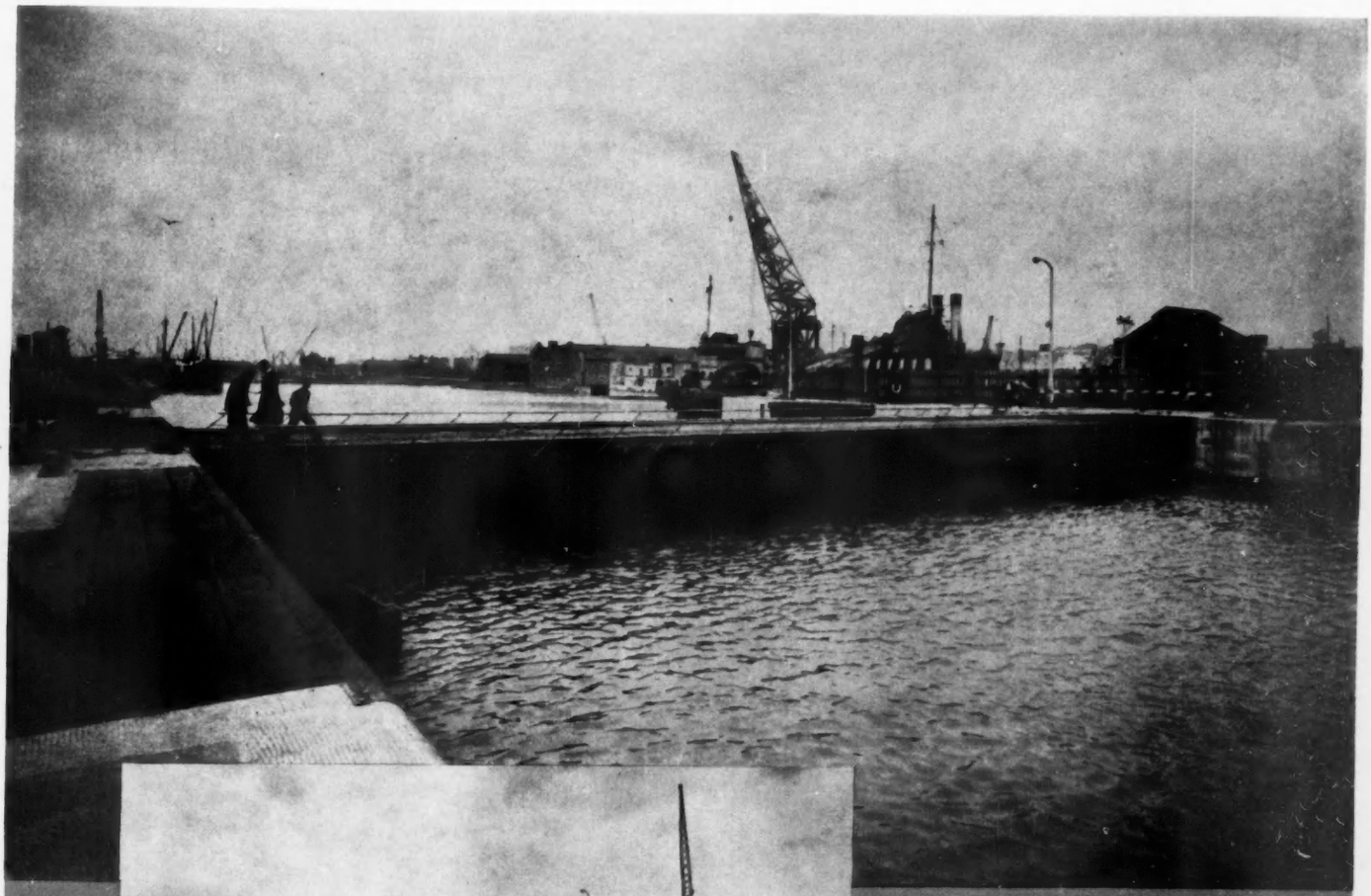

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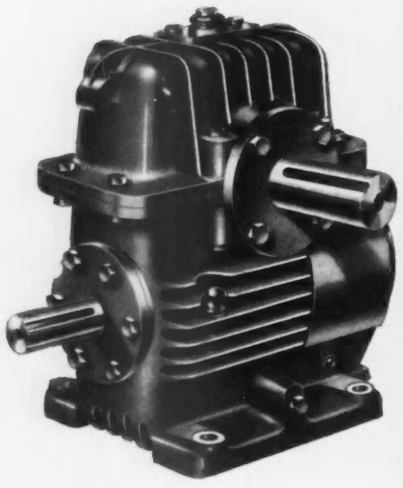

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